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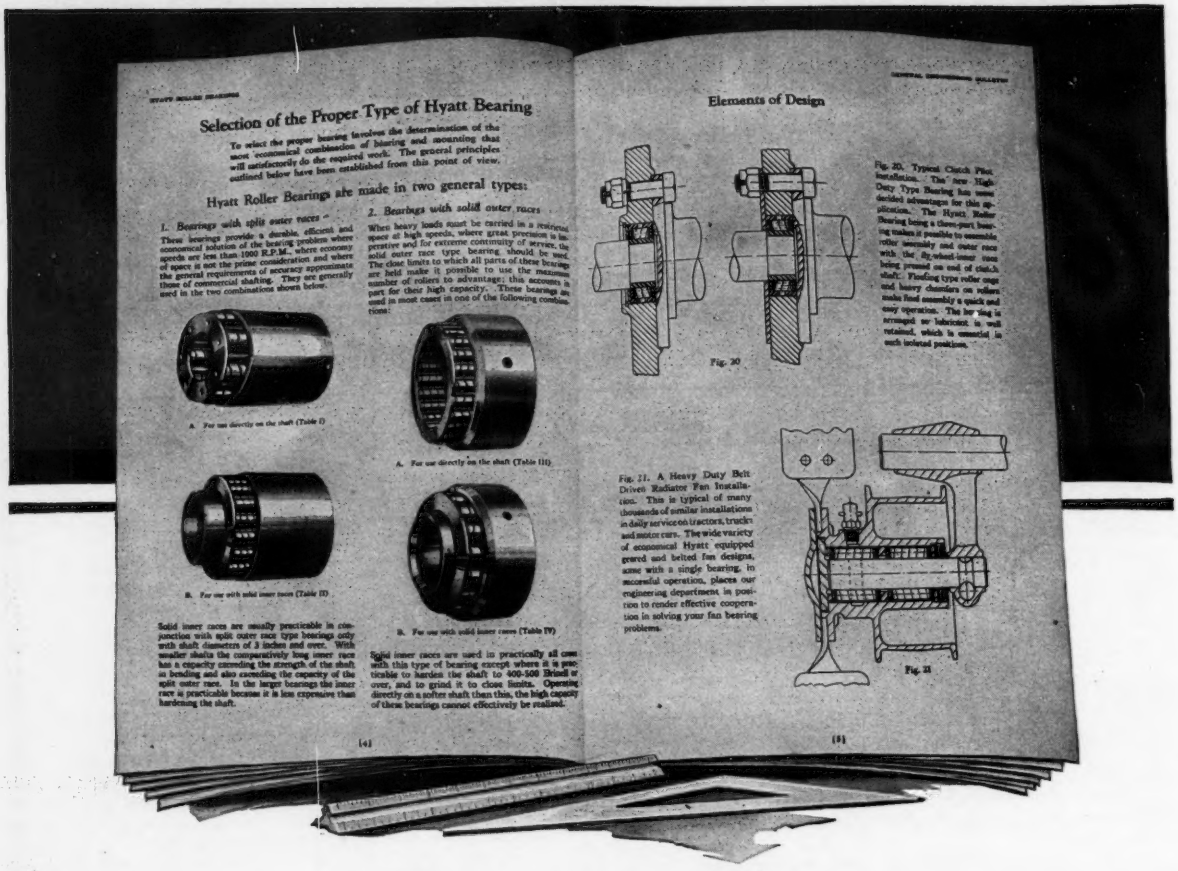
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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

Vol. 8 FEBRUARY, 1927 No. 2

Recent Investigations in the Farm Storage of Apples, Potatoes, and Similar Crops*

By W. G. Kaiser

Mem. A.S.A.E. Agricultural Engineer, Portland Cement Association

CONSIDERABLE amounts of experimental work have been done in recent years to determine the factors controlling the satisfactory storage of apples, potatoes and similar crops on the farm. The significance of these findings to agricultural engineers lies in their relation to the design of storage structures.

By common consent the maintenance of suitable temperatures is considered the most important factor in the successful operation of natural or air-cooled structures. Reports of the U. S. Weather Bureau show that over a large part of the United States normal mean temperatures during four or more of the winter months are low enough to provide favorable conditions for storing the crops under consideration, but some difficulty is introduced by the fact that harvesting, at least of the early varieties, is carried on considerably in advance of the time when these favorable average temperatures prevail. As to the temperature to be desired the recommended range for potatoes is from 32 to 45 degrees Fahrenheit with the weight of opinion favoring temperatures between 35 and 40 degrees. Potatoes held for a considerable time in the neighborhood of the freezing point develop an amount of sugar sufficient to give a sweet taste, but this accumulation of sugar is largely eliminated by holding at a temperature of approximately 70 degrees for a week or more prior to consumption. To avoid delayed and uneven growth when planted it is preferred that seed potatoes be stored at temperatures of 38 to 40 degrees Fahrenheit.

Prevalent opinion is to the effect that the optimum temperature for apples is somewhat lower, 31 to 32 degrees Fahrenheit, but certain recent experiments in Pennsylvania seem to indicate that any temperature below 45 degrees is satisfactory for keeping apples for long periods, and 45 degrees is the accepted practice in England.

Ventilation, another important factor, is interlocked with temperature partly because ventilation has something to do with the temperature maintained, but more because temperature very largely determines the amount of ventilation needed. The stored material consists of living tissues maintaining respiratory processes, for which oxygen must be supplied and the excreted gases removed. These life activities are held at a very low level at the freezing point or slightly above, but increase rather rapidly with temperature, necessitating proportionate increase in the rate of air change. Ventilation also enters into the matter of humidity control.

In the fall directly after harvest, before mean temperatures have fallen to a favorable storage temperature, it has been the practice to employ abundant ventilation at night or at any time when the outdoor temperature is lower than that of the stored product, shutting off or reducing the ventilation when temperatures are higher. But in the case of the underground cellar, the most common type of storage, it has been found that such ventilation as is obtainable has relatively little influence on temperature, the controlling influence being the ground temperature, and experiments seem to indicate that ordinarily it is not practical to maintain in a bank storage a temperature more than 8 or 10 degrees above or below that of the earth.

Ventilation is particularly important for potatoes, as heating and sprouting occurs in the absence of adequate ventilation. Certain experiments indicate that potatoes should not be stored any deeper than 3 or 4 feet deep in bins, as bins of greater depth showed serious deterioration in the middle. The accepted practice of using slatted construction is advised for all sides and bottoms of bins as well as for crates. Ventilating ducts or flues extending through the top of storages have not proven very effective and sometimes are subject to backdrafting, which introduces the danger of freezing at the

*Abstract of paper presented at the 20th annual meeting of the American Society of Agricultural Engineers, Lake Tahoe, California, June, 1926. The paper in full will be published in the 1926 Transactions of the Society.

These pictures show a fruit storage cellar under construction for J. W. Lewis & Brothers, Pittston, Pennsylvania. It is of the cinder block wall and concrete slab type. The cellar is 30 feet wide, 100 feet long, and 10 feet high, and has a capacity of 11,000 bushels

Orderly marketing, which figures largely in the farm economic program, has as its first premise efficient storage under producer ownership—distinctly an agricultural engineering matter.

lower end in severe weather. Electric fans and blowers have been tried with varying effectiveness. In at least one case they served to emphasize the tendency for dead air pockets to form in the corners, and the importance of avoiding such a condition.

Some experiments have been made with the use of ice for cooling, chiefly as a means of bringing down the temperature more promptly after harvest in the early fall. One such experiment conducted at the Purdue University farm used about 25 cents worth of ice for each bushel of apples in storage, and indicated that under certain circumstances it was a profitable expedient.

The possibilities of insulated construction for farm storage structures have been largely neglected. However, a test of an above-ground storage house 30 by 60 feet in size, having walls insulated with 6 inches of granulated cork and the ceiling with 4 inches of the same material, gave promising results. On December 26 when the thermometer dropped to 4 degrees below zero, and also on January 12 and January 29, when the temperature fell below zero, the temperature inside the storage house dropped only one degree on each occasion. The 500 bushels of apples in storage at the time were not considered capable of asserting any marked temperature influence at the temperature being maintained, in the neighborhood of 35 degrees, nor was any artificial heat supplied.

The third important factor in farm storage of potatoes, apples and similar crops is humidity. On the one hand there should be sufficient moisture in the air to avoid wilting or shriveling of the products, and yet there must be no deposition of free moisture on the surface of the stored material, as that would lead to the growth of molds and perhaps other kinds of undesired plant life. The consensus seems to be that a relative humidity of approximately 85 is the optimum. In storages which have earth floors which remain constantly damp humidity is usually pretty well taken care of, but when the earth becomes dry it may be advisable to sprinkle it. Excessive ventilation, particularly when the outside air is dry, such as occurs when the doors are opened, results in a sharp drop in humidity, but return to normal occurs promptly after closing the openings, and such short drops in humidity are not particularly objectionable.

Management plays a dominant part in the successful storage of the crops in question on the farm. Not only must the operator understand the part played by each of the controlling factors—temperature, ventilation, humidity—and their interrelation, but he must maintain constant watchfulness to take advantage of changes in outdoor weather conditions.

Foot Pressures of Cows and Horses

By M. A. R. Kelley

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IN MAKING a study of materials suitable for cow stall floors, it is desirable to know the intensity of the load to which the flooring is subjected.

As there appears to be little published data on the subject of foot pressures of animals, I was fortunate in having an opportunity for making measurements of hoof areas when a number of cows were being slaughtered for experimental purposes.

It is difficult to measure the hoof area of a live animal. The measurements upon which the following is based were obtained by tracing the outline of the hoof on a piece of paper, after the animal was killed and before any shrinkage of the hoof could take place. The areas of these tracings were then obtained by means of a planimeter.

The weight given in the first column of the accompanying table was obtained prior to killing and after the animal had been kept from feed and water for twenty-four hours. This weight is somewhat less (50 to 100 pounds) than the usual live weight, but its use avoids the variations due to differences in feeding. Hence, the ordinary foot pressures exerted by the cow will be slightly greater than those given in the last column.

The weights in the second and third column were obtained by first weighing the front half of the animal and subsequently the rear half, the edge of a platform scale being placed midway between the front and hind feet. It will no doubt surprise many to learn that the fore quarters are heavier than the hind quarters, as shown in the table. The sum of the two weights, front and rear, is not the same as the total live weight given in the first column as they were not obtained at the same time. The first weighings are those of animals kept from feed, while the latter are weights of the animals under normal conditions of feed and water. When one considers that the head, shoulders, heart and lungs and surrounding organs are largely supported by the front feet the greater weight of the front quarters is readily understood.

It is reasonable to expect that nature would provide the same proportional bearing area for all four feet and this appears to be true since the area of the front feet is found to be larger than that of the hind feet.

It is also interesting to compare the bearing pressures of horses' feet with that of cows'. J. H. Shephard, of the North Dakota Agricultural Experiment Station, led a horse weighing 1352 pounds across a platform scale and found 700 pounds of weight on the front quarters and 640 pounds on the rear. He found the average surface area of the foot to be 31¾ square inches, but did not record the sizes of the front and hind feet separately. Observations show the front feet of the horse, as well as of the cow, to be the larger. The average intensity of foot pressure of the horse referred to above, while walking, is approximately 21 pounds per square inch.

These data are of interest to those studying materials for floor construction and the data relating to horses also will aid in approximating the compacting effect of the horse's foot on the bottom of the plow furrow.

TABLE SHOWING FOOT PRESSURES OF CATTLE

Description of animal	Live weight, pounds			Area of feet in square inches			Average pressure lbs. per sq. in.
	Fasting	Front	Rear	Front	Rear	Total	
Holstein calf, 3½ months	220			9.06	8.02	17.1	12.9
Holstein cow	1304	820	643	29.64	25.71	55.4	23.5
Holstein cow	1329	790	627	35.32	26.82	62.2	21.4
Jersey cow	1104	703	490	29.34	25.00	54.3	20.3

Financial Problems of the Reclamation of California Lands*

By William Durbrow

Secretary-Manager, Glenn-Colusa Irrigation District; President, Reclamation District No. 2047

THE federal government has used the word "reclamation" in designating a particular bureau of one of its departments which is primarily concerned in the putting of water upon desert or arid lands in order that they may become productive. On the other hand, we, here in California, have used the word "reclamation" to designate certain districts having to do primarily with the taking of water off the land, either through drainage channels or by levee protection. In contradistinction to this, we use the word irrigation to designate putting water on the land. In the broad sense of the word, reclamation covers both of these processes by which lands at one time unproductive are brought into productivity.

When this subject was first handed to me for discussion. my first thought was that the narrow meaning of reclamation, as we apply it here in California to certain districts having to do with the drainage or levee protection of lands, was intended. I was glad to find, however, that instead of this the broader term for reclamation was intended for my subject, involving as it does both the putting on of water as well as taking it off.

For the purpose of the present discussion, the primary consideration is that both of these processes require the expenditure of money. In the expenditure of this money, whether it be done wisely or foolishly, depends largely the success and well-being of the multitude of farmers of our state depending upon the productivity of our soils for their livelihood.

There are three broad divisions into which, for the purpose of this discussion, may be thrown the subject of financing the reclamation of our lands: (1) Government financing; (2) reclamation district financing; (3) irrigation district financing. This leaves out of consideration, individual or corporation financing with which we are not concerned here.

Under the heading of government financing, we have, in the first place, the expenditures of federal government authorized by Congress for the protection and improvement of our navigable streams. These expenditures of the national government have been of enormous value in aiding the farmers of our overflowed valley regions to keep the rivers within definite channels and in carrying out a great scheme, which, when completed, will give adequate protection to lands that are protected by levees along our streams. This method of financing involves simply an appropriation from Congress with no provision for repayment out of the income from the land.

There is now before Congress and the state legislature a plan for a more complete coordination with the landowners, by which the government and the state each pay one-third of the cost of the work already done or to be done in the control of our two main rivers, and it is to be greatly hoped that these plans will be consummated and relief given to highly productive sections of our state, which are today staggering under a greater burden than it appears possible, in some cases, for them to carry.

Also under the heading of government financing, we have the expenditures made through the Reclamation Service. These expenditures have been made largely with interest-free money, the government contracting directly with the owners of land within the projects for a subdivision of the land owned by such landowners into small units and the paying back of the cost of construction of the system built by the Service over a long period of years. This has not been an important item in financing the reclamation of lands in California. There has been much discussion and comment upon the success or failure of this form of financing. In a general way it may be said that the financing of irrigation districts, springing as it has from the economic need for such irrigation, has been more successful, has met charges more promptly and has been productive of a more rapid increase in colonization than has the more or less forced development that has come about through the development of arid regions through the operation of the Reclamation Act, sponsored too

*Paper presented at the meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, at San Francisco, December 11, 1926.

First irrigation on the Grand Valley (Colorado) project of the U. S. Reclamation Service

Reclamation in general, and irrigation projects in particular, afford an outstanding example of how closely correlated must be the technical, economic, and social aspects of engineering in agriculture, and emphasize the importance of agricultural engineering as a distinct profession. Not only must the engineer be guided always by the economic feasibility of his works as paying investments, but he should strive to bring engineering efficiency into the methods of financing reclamation projects.

often by the sectional desire for the expenditure of government money.

I venture the suggestion that the funds made available by the Reclamation Act would have been of greater economic importance to the Western states had the government, instead of dealing directly with the landowners and later with the settler, required the organization of districts financed through the ordinary method of irrigation district financing for the distribution of water and then proceeded to do the big things that economically, for the landowner, were impossible. This would involve the building of dams, the equalization of stream flows and the transportation of water over great distances to their place of use.

There have been projects in the past and they are becoming more numerous as the cheaper waters of the West are being used up, which are impossible from a financial standpoint when related back to the value of farm products, but which, on the other hand, may be quite economically proper from a governmental and community standpoint. These projects, it seems to me, must, as time goes along, be undertaken either by national or state agencies, and the financial burden involved in them must not and should not be put altogether upon the tiller of the soil. We have examples of such projects in the Boulder Canyon dam and the equalization of the stream flow of the Sacramento River, which latter project must necessarily be accomplished if our two great valleys are to continue to prosper and grow agriculturally.

We have but to mention the financing of reclamation districts in California, when there comes into the minds of any one, who has had connection with such districts, the word "warrant". The reclamation warrant, except in a few favored sections, does not, today, have an enviable reputation among the financial institutions of California. While it has been customary for both irrigation districts and reclamation districts to issue warrants without funds on hand to meet such warrants, the laws creating the two forms of organization differ greatly as to repayment of such obligations.

The irrigation district law requires that each year assessments be placed upon lands of the district sufficient to meet all outstanding warrant indebtedness, and in all properly functioning districts, at the present time, this is being done with the result that, when such warrants pay their calls, as they frequently do upon the banker, they do not outstay their welcome.

The reclamation law, on the other hand, does not have a similar provision for establishing a due date, and warrants issued must often await the placing of an assessment upon the lands of the district which, at the time of the issuance of such warrants, may not as yet have even been commenced and thereafter must await the collection of such assessment. As the placing of an assessment is often a complicated affair and subject to many legal delays and resubmissions to boards of supervisors, we find the reclamation warrant long overstaying its welcome with the banker in many cases.

Because of this uncertainty as to the date of payment, we find warrants issued by most reclamation districts saleable only at heavy discounts. This practice of discounting warrants may not work any great hardship where the number of landowners in a district is small, as the warrants are then often sold to the landowner more or less proportionately and held against the payment of his assessment. In the larger districts, however, such discounting of warrants means to the average landowner inevitably an increase of his financial burdens. This form of financing undoubtedly grew out of the necessities surrounding the protection of levees along the rivers where large expeditures could not wait on orderly procedure. However, there is no doubt but that a method of financing, which heavily discounts the paper of a district and then adds compounded interest at 7 per cent of its face value over an uncertain period of years, has done much to discourage the landowner on some of the most productive lands of our state.

Within the confines of the Sacramento-San Joaquin Drainage District, it is estimated that there has already been spent some $72,000,000 largely under these conditions, and outside of that district it is probable that another similar sum has been spent, making in all some 130 or 140 million dollars spent under a system of financing which causes a heavy discount and a maximum rate of interest in the money marts. it would seem that self-interest of those owning land within reclamation districts would dictate some change in the law, giving a more definite due date on papers issued by such reclamation districts, and in that way create a more favorable impression among the investors in such securities.

It is not at all unusual in reclamation districts to find the following procedure in the doing of very large constructive works: First, an engineer's estimate is prepared, which is adopted by the board and receives the necessary endorsements of the reclamation board and board of supervisors; then, without first raising the money by cash assessments or bond issues, work is started and, in some cases, several millions of dollars of constructive work done under the above system of a discounted warrant and without the landowners, who have ultimately to pay the bill, having had any opportunity to make known his desires in the matter. This work, in some cases, is entirely completed before even the assessors having placed upon the lands assessments based upon benefits to be derived from such work. The first opportunity the landowner is given to make any objection is when he finds the money already spent and he is called upon to defend his assesment before a board of supervisors. After this he has the choice of either paying in cash his assessment, which is usually too high for the ordinary farmer to pay out of current revenues, or voting for a bond issue based on such assessment upon his land. Here again is a chance for an additional discount in the selling of such bonds and a further burden placed upon the lands.

The law should, I believe, be changed in this respect, putting some limit upon the trustees of reclamation districts in the expenditure of money ahead of the raising of such money. This change must of necessity be done carefully in order not to embarrass the districts where emergencies arise in which money must be spent rapidly to avoid great damage. Should such a change be possible in the law—and I believe it is—it would do more than save the landowner the heavy discount and interest charges which I have already pointed out. In addition to these it would provide for doing the work in his district on a cash basis and any one who has been connected with such work realizes that contract prices are considerably lower where cash has been made available for doing the work.

The irrigation districts of the state, of which there are now ninety in active operation, comprising an acreage of 3,583,284 acres, have to date voted $135,000,000 in bonds, which money has been spent or is being spent in constructive irrigation works. While it can not be claimed that the irrigation district law is a perfect one from a financial standpoint, the results of their operations can be pointed to with some considerable satisfaction by our state.

Contrary to results often employed by the reclamation

districts, this sum of 135 million dollars has, to a very large extent, been spent only after the bonds have been sold and money in hand to pay for the work to be done. Although I have not the figures necessary to prove the contention, I doubt if it can be denied that these irrigation districts have obtained a larger amount of work done per dollar expended than have the reclamation districts under their form of financing.

The present California Irrigation District Act came into being in 1897. Since that time some 110 districts have been formed, ninety of which are now active. The inactive districts, with an area of 332,468 acres, have no bonds out against them. The active districts with 135 million dollars of bonds show a very high percentage of successes. Out of the 3,500,000 acres included within their boundaries, some 100,000 acres have had difficulties and have defaulted to some extent in their payments. This, as may be readily seen, is a very small percentage of the whole and ranks high when we consider other bond issues, whether they be by railroads, public utilities or industrials.

It is believed by those, who have followed carefully irrigation district financing, that the bonds of irrigation districts—and I believe this should apply also to reclamation bonds—should command a higher price and a lower rate of interest in the money market than they do. In order to accomplish this greatly to be desired result, some few changes will probably have to be made in the law itself. At the present time, there is not a proper provision for winding up or straightening out the affairs of defunct or defaulting districts. The investor in bonds wants to know, first, that his money has ample security back of it, and, second, should difficulties come he desires proper provision made by which his money can be refunded to him through the sale or control of the assets back of his bonds. It is believed that this detail can be worked out, and, at the present time the Irrigation Districts Association of California has a committee working upon the matter.

Another matter that is holding back the price of irrigation district bonds is the attitude of the state itself toward them. Under a provision of the law, when irrigation district bonds are issued, the district issuing such bonds may apply to a bond certification commission composed of the state superintendent of banks, the attorney general, and the state engineer, to certify such bonds as proper investments for savings banks, trust funds, et cetera. This function is an important one and of necessity great care should be used that only the bonds of such districts are certified as have been organized under proper economic conditions. It is possible that some change should be made in this phase of the law, requiring some more careful investigation than perhaps has been made in the past before certification. The individual investor can not of necessity know the details about the irrigation bonds in which he is investing and therefore must rely upon the certification of the commission in making his investment. Also it would seem that when such certification has been made by duly authorized officers of the state, the state itself, without question, should accept such bonds as security wherever municipal or district bonds are called for. If this were done and the state stood squarely back of its own act in certification of such bonds, a very greatly increased market would be had for these bonds, as the banks of the state are large purchasers of the bonds which they use in protecting deposits of state and county monies. I regret to have to say that this state has not, in all cases, taken the broad point of view that it should in these matters and has given marked preferment to municipal bonds, even though in some cases the municipality issuing such bonds is wholly within an irrigation district over the irrigation bonds themselves.

At the present time, the halls of Congress and the columns of our daily papers are filled with discussions of various plans to rescue the farmer from the serious plight in which he now finds himself. The better financing of our irrigation and reclamation institutions, while it is not a cure-all for our agricultural troubles, is a definite step in this direction and should receive the serious consideration, both of our legislators and of our landowners who, under present conditions, ultimately pay the bill, and will continue to do so until they find a way, as have our public utilities and trust controlled industrials, to pass their extravagances and mistakes on to the consumer of their products.

Does Your Carburetor Air Inlet Face Forwards?

By A. H. Hoffman

Mem. A.S.A.E. Research Specialist in Agricultural Engineering, University of California

A TEST covering a period of three years made at the California Agricultural Experiment Station, at Davis, gives results that would seem to show rather conclusively that the air inlet of the carburetor of an automobile should face backwards rather than forwards.

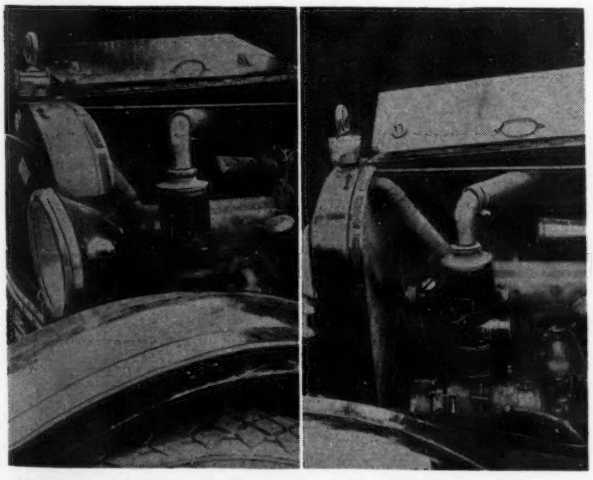


Fig. 1. (Left) With the air cleaner inlet facing upstream the dust caught per mile was three and one-half times as much as it was when the cleaner was turned around as in Fig. 2

Fig. 2. (Right) Facing the air inlet downstream reduced the dust per mile to less than one-third

On December 29, 1923, a Dodge touring car was equipped with an oily filter type air cleaner placed with the inlet facing forwards as shown in Fig. 1. One year later the dirt inside the cleaner was removed and weighed after being freed from oil. The cleaner was reoiled and replaced, the conditions being the same as before except the inlet facing backwards as shown in Fig. 2. It was then left for two years without any servicing. The average dust-per-mile caught by the cleaner was three and one-half times as much while the air inlet faced forwards as it was while it faced backwards. The car was used in northern and central California only and for the same general purposes throughout the three years. Climatic conditions, while not exactly the same, were not sufficiently dissimilar to vitiate the results. The data are tabulated below.

A laboratory test along similar lines, using apparatus designed for determining the efficiency of air cleaners of the radiator fan type, gave similar results. Two tests were made under conditions as nearly identical as were possible except that in one case the air inlet, which was located 6½ inches behind the radiator fan, faced up stream while in the second case it faced down stream. In the first case 2.35 times as much dust was caught as in the second.

Table Showing Dust Caught With Carburetor Air Inlet Facing Forwards and Backwards

Inlet placing	Time, years	Mileage	Dust caught, grains	Dust caught per mile, grains	Ratio
Forwards	1	3646	9.650	.00265	3.5
Backwards	2	8705	6.553	.00075	1

Making the Farm Chimney Safe

By Wallace Rogers

Chairman, Agricultural Committee, National Fire Waste Council

WITH an annual farm fire loss of $150,000,000 it should not be necessary to urge upon agricultural engineers their opportunity in reducing this economic waste. And when we consider that at the same time 4,000 human lives are lost, it seems to me that the engineer's position of authority imposes on him a human obligation to go out of his way in promoting safety against fire hazards. The further fact that defective chimneys and flues are responsible for 35 per cent of farm dwelling fires and 13.4 per cent of all farm fires indicates that proper chimney construction and management offer the greatest single place for progress, at least in relation to the farm home where most of the loss of human life occurs.

The things that make a chimney safe or hazardous are not influenced appreciably by whether the chimney is in a farm home or a city dwelling, but the well-nigh total lack of fire fighting facilities on the farm and the remoteness of neighbors to discover incipient fire during the absence of the family and lend assistance in saving life and property point to the advisability of observing a higher degree of precaution on the farm than in the city or village.

The experience of the fire insurance companies has shown what are the defects in chimneys which result in fires, and a number of these faults as observed by insurance inspectors are shown in an accompanying illustration in diagrammatic fashion.

The chimney shown in No. 1 was built on a slant for part of its length to bring it through the roof at the ridge. It bound at that point, settled and broke off. Being fundamentally wrong such a condition can not be made safe by repair. No. 2 is another case of breaking off due to binding at the ridge, the trouble in this case being invited by building the chimney on a bracket instead of carrying it down to a proper foundation.

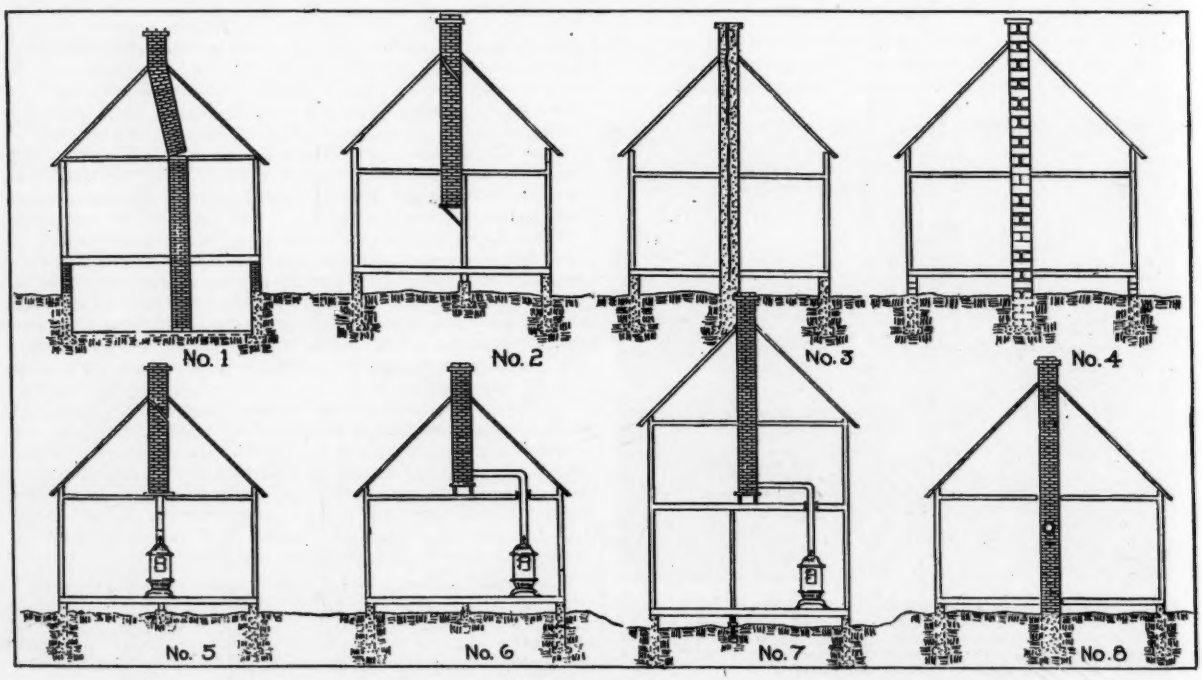
The chimney shown in No. 3 was of monolithic concrete construction, and it cracked the entire height on both sides. It, too, can not safely be repaired. Concrete is not adapted to chimneys and flues for farm buildings. In No. 4 the chimney is constructed of concrete block. They are unsafe because of the extent to which the concrete blocks expand and contract with temperature changes.

The chimney shown in No. 5, being supported on ceiling joists is similar to that in No. 2 in that binding at the ridge resulted in pulling the chimney in two when the building settled. In addition it is unsafe to have a stovepipe enter a chimney at the bottom. In No. 6 the hazard of bottom pipe entry is replaced by another as bad or worse, namely, running the stovepipe upward through a ceiling, a hazard which could be reduced somewhat by a metal thimble but which still would be unsafe due to carrying the pipe through a concealed attic space. In No. 7 the situation varies only in that after passing through the ceiling the pipe is in an upstairs room instead of an attic space. Such an arrangement never is good, but here the horizontal run of pipe is so close to the floor and the rugs and other objects which may be upon it that it is a particularly objectionable case.

No. 8 shows a chimney well built and safe for the most part, but having an opening too large for the pipe used, affording space for sparks to escape and set fire to any combustible material that may be about.

The important points in the construction of a safe chimney are shown in another illustration (No. 9). To be safe under farm home conditions a chimney should have its own independent foundation in the earth with a footing at least 12 inches larger than the chimney itself. It will be noticed also that the joint between the chimney and roof is made with flashing in such fashion that there is a clearance of 2 inches between the brick and any adjacent woodwork, not only avoiding contact with combustible material but also preventing binding of the chimney and pulling it apart in case of uneven settling.

Complete safety requires the outside walls of chimneys to be at least eight inches or two courses of brick in thickness; however, a four-inch thickness when provided with fire-clay flue lining is fairly safe. The fire-clay lining provides a smooth flue which is very largely self-cleaning, minimizing



friction resistance to the draft and preventing any material reduction of cross section due to soot. There also is avoided the fire hazard arising when a soot accumulation of any considerable amount burns out, a hazard consisting not only in the sparks discharged from the top of the chimney but in the excessive and uneven heating of the chimney itself.

Chimneys should be carried at least three feet above flat roofs and two feet above the ridge of steep roofs. It is desirable for other reasons as well as safety that the chimney be built with a separate flue for each fire to be served.

It is important that no floor joists or woodwork of any kind be run into chimneys or flues and that no casing, lathing, furring or other wood be placed closer than two inches from the chimney breast.

Whenever there is an unused opening, more particularly a stovepipe hole in a chimney which is in service at another connection, it is extremely important that the unused opening be closed by a tightly fitting metal flue stop. If such a hole be left open there is danger of fire being started in the room adjoining, and if the opening is stuffed with rags, paper or other combustible material a fire is highly probable. It is desirable that flue stoppers or other covers for chimney openings be installed with sufficient firmness to resist the pressure set up by smoke explosions, particularly where soft coal is used for fuel.

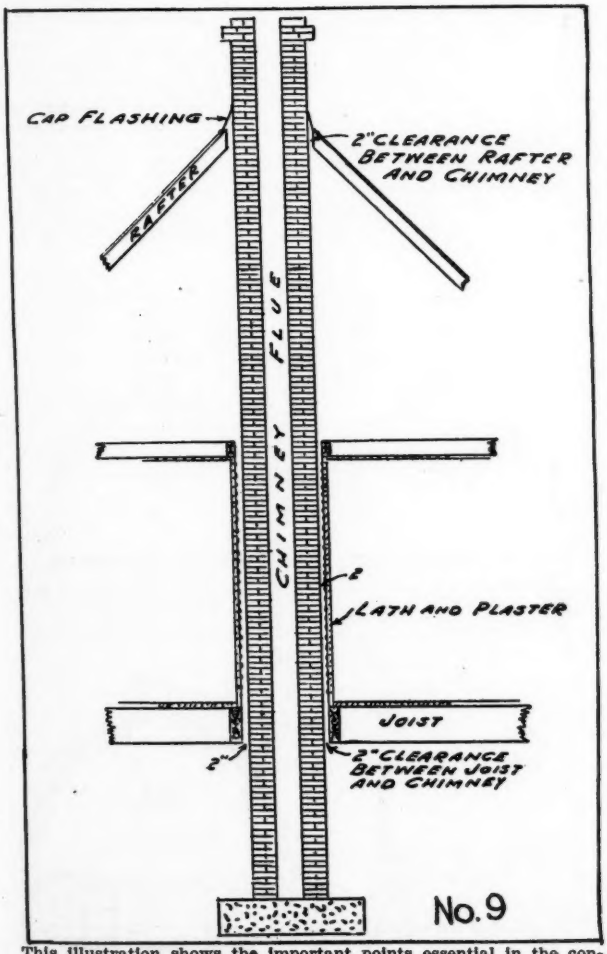
Chimneys constructed as herein advised will meet the requirements of building codes in many cities. Considering the lack of fire-fighting facilities on the farm it seems obvious that construction required by law for public protection in the cities is none too good for protection on the farm.

Although not a part of the chimney, it seems proper in conclusion to direct attention to hazards arising from metal smoke pipes. This has to do particularly with furnace smoke pipes which commonly are disused during the entire summer, and at the same time are located in a basement where the air is moist. In addition to the ordinary condensation of moisture which would corrode any ferrous metal similarly located there are in the soot from many fuels certain chemical substances which are corrosive in nature when wet, and either themselves are or are associated with substances of a hygroscopic nature, resulting in a combination of conditions which rust through sheet iron or steel very rapidly. A pipe so corroded may show many small holes through which sparks or burning soot may escape, but perhaps a more dangerous condition is represented by pipe which has rusted away until nothing remains but an extremely thin skin, apparently consisting of a kind of scale originally forming the surface of the metal, which may collapse without warning at any time, especially under the expansion stress and weakening effect of a hot fire or burning soot. Before starting fire in the fall all such smoke pipes should be inspected not only by appearance but by scratching and prodding with a large nail.

Chimney Specifications

By Homer R. Linn

Mem. A.S.A.E. Heating Engineer, American Radiator Company



This illustration shows the important points essential in the construction of a safe chimney

EDITOR'S NOTE: These chimney specifications as prepared by Mr. Linn are based on the Underwriters Chimney Ordinance and have been adopted and approved by a large number of builders and building organizations.

THE walls of the chimney shall be of brick and shall be lined with fire clay flue lining. The joints of the flue lining shall be made air tight. The clean-out space at the bottom of the chimney shall be air tight when the clean-out door is closed. Flue lining shall start at least 4 inches below the bottom of the smokepipe intake and shall be continuous the entire height of the flue and project at least 4 inches above the chimney top to allow for a 2-inch wash and a 2-inch projection of the lining. The wash shall be formed of a rich cement mortar.

Chimneys shall not rest upon or be carried by wooden floors, beams, or brackets, nor be hung from wooden rafters, but shall be built upon concrete or masonry foundations properly designed to carry the weight imposed without danger of settling or cracking.

Flue shall be ——— in. x ——— in. x ——— ft. high, (in no case shall the area of the flue be less than 10x10 inches) built vertical, without offsets and full size from the smokepipe inlet to the top of chimney.

The top of the chimney shall be at least three feet higher than the highest point of the building and in no case shall it be less than thirty feet above the boiler or furnace grates.

There shall be but one connection to the flue to which the boiler or furnace smokepipe is connected. The boiler or furnace smokepipe shall be thoroughly grouted into the chimney and shall not project beyond the inner surface of the flue lining.

The chimney flue to which the heating boiler is connected shall be subjected to a smoke test by the mason contractor in the presence of the architect or his representative, after the mortar has thoroughly hardened, and must be smoke tight.

The method of conducting this test shall be as follows: With a good fire in the boiler or furnace, or in the base of the chimney, put about a square yard of tar paper on the fire. As soon as smoke appears at the top of the chimney close the top of the flue with a piece of old carpet or wet newspapers held down by a weighted board. Keep the tar paper burning in the firepot for five minutes. The architect or his representative shall sign an acceptance in triplicate, stating that the chimney was tight under the above test, and shall give one copy to the mason contractor, one copy to the heating contractor and one copy to the owner.

In stable ventilation we have a case wherein agricultural engineering, albeit a young art, has outrun the science of the industry it serves. Even admitting the engineering aspect to be the easier, the fact remains that engineering is assuming the leadership in modern agriculture.

Air Movement Studies in Dairy Stable Ventilation

By F. L. Fairbanks

Mem. A.S.A.E. Associate Professor of Rural Engineering, New York State College of Agriculture

WE WILL all agree that adequate ventilation of the dairy stable is desirable, but there is quite a difference of opinion as to what is meant by the term, "adequate ventilation."

As yet it seems difficult to find conclusive evidence that the purity or impurity of the stable air affects the milk flow of dairy cattle. We do, however, have data which shows that for a given structure a certain definite amount of air flow through the stable is necessary to prevent the walls and ceiling from becoming wet, thus causing uncomfortable stable conditions and premature decay of the structure.

In our early studies at Cornell University, we were confronted repeatedly by the question, "How does the air move through the barn?" As "necessity is the mother of invention," it was the necessity of answering this question that led the author, after many failures, to the discovery of a method whereby the air movement could be accurately determined. It is the result of this air movement study, as an important factor in ventilation, that I present in the following discussion.

The four accompanying illustrations represent two types of ventilation systems and two modifications, one of each system. The two primary systems are known by the names "King" (floor outtake, ceiling intake) (Fig. 1) and "Rutherford" (ceiling outtake, floor intake) (Fig. 2). The movement of air into and out of these types is accomplished by the same means, but the air movement through the stable is quite different.

Before observing the air movement through these systems, I want to call your attention to one important factor as determined by this method of tracing air movement, which is that air at a given temperature, entering (through a duct) a room of higher temperature, tends to remain in a column and cause drafts unless its velocity is destroyed.

In the King system the incoming air is directed toward the ceiling. (Fig. 1). The air movement leaves the intake in a column; it stops and falls around the intake toward the floor diffusing and spreading out as it goes down. Then it moves toward the cows where most of it rises about the cows forming two convection currents for each row of cows. This accomplishes a thorough mixing of the fresh air and stable air, and it is this mixture which is going out of the outtake flue. Also, because of the floor outtake, this system has what I would call a heat reservoir (all the space above the outtake opening level), and we find by actual test that this heat reservoir has a decided effect in helping to maintain uniform stable conditions.

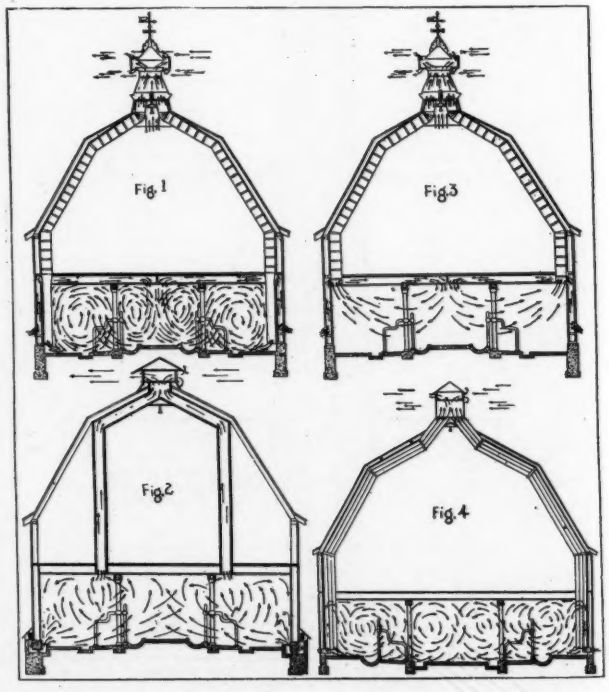
With the Rutherford system (Fig. 2) the air enters in the same general direction as in the King (Fig. 1), stops and falls to the floor spreading out and diffusing as in the King, but with the convection currents less positive, not quite the degree of mixing and a greater tendency of direct air flow from intake to outtake. The outtake opening being at the ceiling, there is no possibility of a heat reservoir as in the King, and, therefore, this system becomes more sensitive to weather changes although giving good distribution of air.

Fig. 3 represents what I term a modified Rutherford system. It has ceiling outtakes and ceiling intakes. The intake is also directed differently than in the other models to show the air action mentioned before. In this system there is an absence of the convection currents so strongly marked in the King, and also a tendency for the incoming air to short circuit from the intake to the nearest outtake.

Fig. 4 is a modification of the King system which has resulted from our findings on air movement. The design of this system which we have called the Fairbanks-Goodman system is based on our findings and in operation has functioned as we anticipated. It differs from the King in two respects, one in the placing of intakes and outtakes both in the side walls of the stable, and second, in directing the incoming air. The floor outtake and ceiling intake have been retained.

You will observe that the circulation within the barn is practically the same as with the standard King system, the exception being that with the modification the incoming air from either side reaches the further side of the stable. With the King, the incoming air travels only three-quarters of the way across during the mixing.

As I stated before, we do not know definitely that socalled "adequate ventilation" increases the milk flow or improves the health of the cow. We do know, however, the engineering requirement for moisture removal while maintaining stable conditions that are permissible. I believe that good air in the dairy stable does have a decided influence on the health and production of the animals, and I hope that in due time veterinary medicine, animal husbandry, dairy industry and chemistry will join hands with agricultural engineering to prove this point.



*Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at State College, Pennsylvania, October 11 and 12, 1926.

Four Important Factors in the Manufacture of Concrete Pipe for Alkali Soils*

By Dalton G. Miller

Mem. A.S.A.E. Drainage Engineer, Division of Agricultural Engineering, U. S. Department of Agriculture

THIS paper is based chiefly on experiments in the laboratory with cement concrete and cement mortar cylinders stored in artificial solutions of the sulphates of magnesium ($MgSO_4$) and sodium (Na_2SO_4). In formulating the conclusions consideration also has been given the first year's test results of experimental cylinders and drain tile installed under field conditions in alkali soils and water in Minnesota, North Dakota, and South Dakota. As the purpose of this work has been primarily to determine the limitations of the use of concrete tile in alkali soils the types of concrete considered have for the most part been such as might be suitable for the commercial manufacture of pipe. In these studies there have been made a total of about 20,000 cylinders and 2500 drain tile.

A report covering these experiments in detail is now in preparation and in the near future will be issued as a University of Minnesota bulletin. It is, therefore, the purpose at this time only to present in condensed form what have been found to be some of the more outstanding essentials in concrete making that develop greatest resistance to alkali.

The length of this paper does not permit a description in detail of the laboratory routine and cylinders. Mention, however, is made of such points as is believed will make possible a clear understanding of the data presented.

All cylinders in solutions in the laboratory are stored in eathenware jars and the solutions changed at intervals of one or two weeks. It was found, as indicated by Fig. 1, that this change must be regular and frequent if consistent results were to be obtained.

Two-by-four-inch cylinders have been used in this work as this size reduced to a minimum the volume of concrete in all jars. Moreover, the two-inch diameter roughly approximates the thickness of the wall of the average size of tile used in larger drains.

The cylinders are made in batches of nine, each series consisting of five batches made on different days. In each end of three cylinders of each batch a one-inch brass screw is set in neat cement. Changes in volume are determined by measurements between screw heads and it has been found that an increase in length of 0.01 inch in a 2-by-4-inch cylinder ordinarily indicates a 50 to 70 per cent strength loss. The laboratory standard concrete cylinder is mixed 1:3 by volume with a consistency of 1.00 (water ratio, 0.60) and the aggregate graded to produce a fineness modulus of 4.67, the largest pebbles used passing a three-eighths-inch screen. Some few series of mortar cylinders have been made of standard Ottawa sand with the idea that they fairly well represent poorly graded aggregate as too often used in smaller size tile.

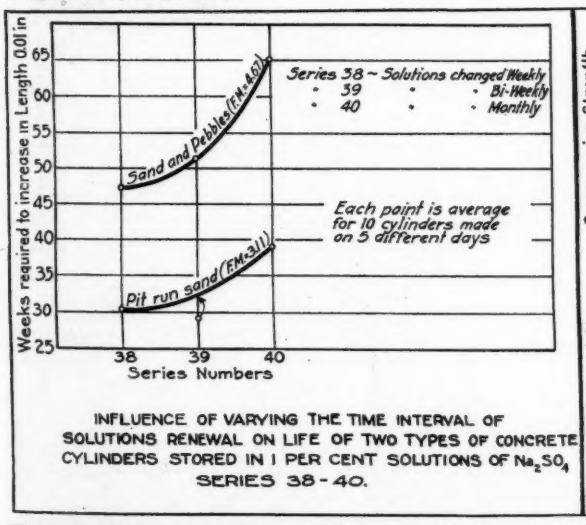
Extreme care has been exercised in making the experimental cylinders of a series that they be as uniform as possible and variables have been introduced singly in the different series that the influence of any variable on the life of cylinders of a series might definitely be ascertained and recorded.

No way has yet been found to make portland cement concrete that entirely resists all alkali action but much has been learned of the very great influence exerted by the following four factors: (1) Alkali resistance of the cement; (2) quantity of cement used in the mix; (3) quality of the concrete as measured by the 28-day compressive strength; and (4) conditions under which the concrete is cured.

By careful consideration of these four factors portland cement concrete pipe can be made that will be entirely satisfactory for use in alkali soils where the total content of the sulphates of magnesium ($MgSO_4$) and sodium (Na_2SO_4) is less than 2500 parts per million, while pipe made with extreme care may satisfactorily resist even much more severe conditions, the exact limits of which have not yet been fixed.

These four factors will be considered in the order in which they have been enumerated but which is not necessarily that of relative importance, as all the items are more or less closely related and are somewhat difficult to classify as to individ-

*Paper presented at the Reclamation Division session of the 20th annual meeting of the American Society of Agricultural Engineers, Lake Tahoe, California, June, 1926. This is also Journal Series Paper No. 625 of the University of Minnesota. It represents the results of experiments at University Farm, St. Paul, Minnesota, in the drain tile laboratory conducted by the Department of Agriculture of the University of Minnesota, the Department of Drainage and Waters of the State of Minnesota, and the U. S. Department of Agriculture, cooperating.


Weeks required to increase in Length 0.01 in
Series 38 ~ Solutions changed Weekly
39 " " Bi-Weekly
40 " " Monthly
Sand and Pebbles (F.M.=4.67)
Each point is average for 10 cylinders made on 5 different days
Pit run sand (F.M.=3.11)
Series Numbers
INFLUENCE OF VARYING THE TIME INTERVAL OF SOLUTIONS RENEWAL ON LIFE OF TWO TYPES OF CONCRETE CYLINDERS STORED IN 1 PER CENT SOLUTIONS OF Na_2SO_4 SERIES 38-40.

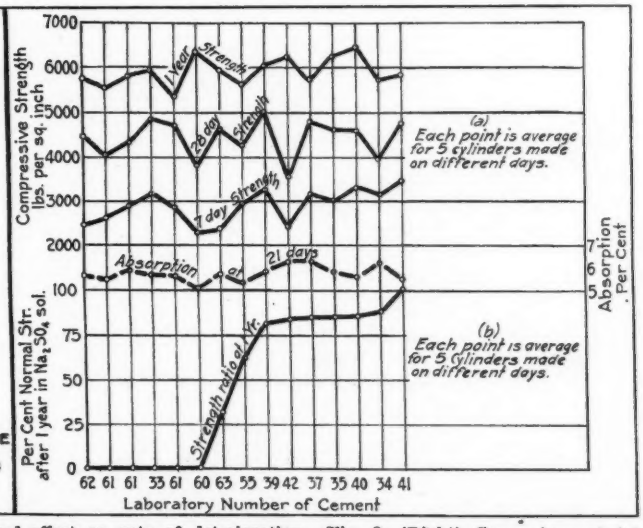

Compressive Strength lbs. per sq. inch
1 Year Strength
28 day Strength
7 day Strength
Absorption
21 days
(a) Each point is average for 5 cylinders made on different days.
Per Cent Normal Str. after 1 year in Na_2SO_4 sol.
Strength ratio all Str.
(b) Each point is average for 5 Cylinders made on different days.
Absorption Per Cent
Laboratory Number of Cement

Fig. 1. (Left) Frequency of renewal of test solutions has a marked effect on rate of deterioration. Fig. 2. (Right) Comparison of (a) strength and absorption of concrete made from portland cement of different brands, and (b) relative resistance to one per cent solutions of Na_2SO_4 as indicated by compression tests after exposure for one year.—Series 261-275

ual importance. It will here be emphasized, though, that consideration must in all cases be given the alkali resisting properties of the particular cement used and the conditions under which the concrete is cured if resistent concrete is to result. These two items are particularly stressed for the reason that heretofore little or no consideration has been given them in the making of concrete which later is to be exposed to alkali soils or waters.

1. Alkali resistance of the cement. In calling attention to the fact that there is a wide variation in resistance of different brands of portland cement it will be said that furthermore there appears to be a considerable difference in resistance of cements of the same brand manufactured at separate plants.

In Fig. 2 is shown results of tests of cylinders from fifteen series after one year exposure to one per cent solution of sodium sulphate while in Fig. 3 is shown a view of a representative cylinder from each of the fifteen series after fifteen months' exposure. In this group all cylinders were identical except that a different brand of cement was used in each of twelve of the series. Cement No. 61 was a mixture of equal parts of cements Nos. 62 and 63. Of the 75 cylinders tested from the solutions, only three had a strength ratio greater than 100 per cent as compared with 75 cylinders from the same series stored in tap water in the laboratory. The three cylinders were made with cement No. 41 and, as a consequence, this series at one year finished with a strength ratio of 101 per cent so that the condition of the cylinders in the various series ranged all the way from normal strength to complete disintegration.

The point may be raised that the order in which these cylinders finished at one year has been more or less accidental and that other lots of the same cements might give entirely different results. Such, however, has not proven to be the case in other tests in the laboratory as given cements have in all cases shown consistent results.

In view of the wide variation in resistance of different brands of portland cements the first essential in making concrete for alkali soils is the selection of the cement. Some little effort has been made in the laboratory to work out an accelerated test by which the resistance of a cement might readily be determined. Results along this line, though, have not yet been entirely satisfactory and, until a satisfactory accelerated test is developed, the following recommendations are at this time made with the idea that cements very low in resistance can be eliminated from consideration for use in concrete for alkali soils and that instead cements of at least average resistance will be selected. For the present, if only this much can be accomplished, considerable progress will have been made in the whole concrete—alkali problem as the work in the laboratory with something like thirty cements apparently justifies the conclusion that of the many brands on the market a very appreciable number of the total are entirely unfit for alkali soils.

There is no reason to believe that the resistance of any cement greatly varies from time to time, so that once it has been established that a given cement is at least of average resistance future tests need be made only often enough to make certain that there has been no change. Consequently the time element involved in the test suggested is not as objectionable as at first thought might appear.

Test the cement for resistance by first making up three or more standard sand mortar briquettes composed of one part cement and three parts standard Ottawa sand, by weight. In making these briquettes follow carefully the specifications of the American Society of Testing Materials[1]. After about twenty hours in the moist closet store the briquettes in distilled water and at seven days test for tensile strength. Retain the two halves of each briquette and, without permitting them to dry out, store one half in a one per cent solution of magnesium sulphate ($MgSO_4$) and the other in a one per cent solution of sodium sulphate (Na_2SO_4). To make up these one per cent solutions, on the basis of anhydrous salts, will require eighty grams of magnesium sulphate or eighty-eight grams of sodium sulphate per gallon of water. The solutions should be kept, about three gallons to a jar, in five-gallon earthenware jars, covered to reduce evaporation, and should be completely changed every four weeks. It is preferable that the temperature of the solutions be maintained as near 70 degrees Fahrenheit as practicable. Not more than 45

[1]A.S.T.M. Standards, 1924.

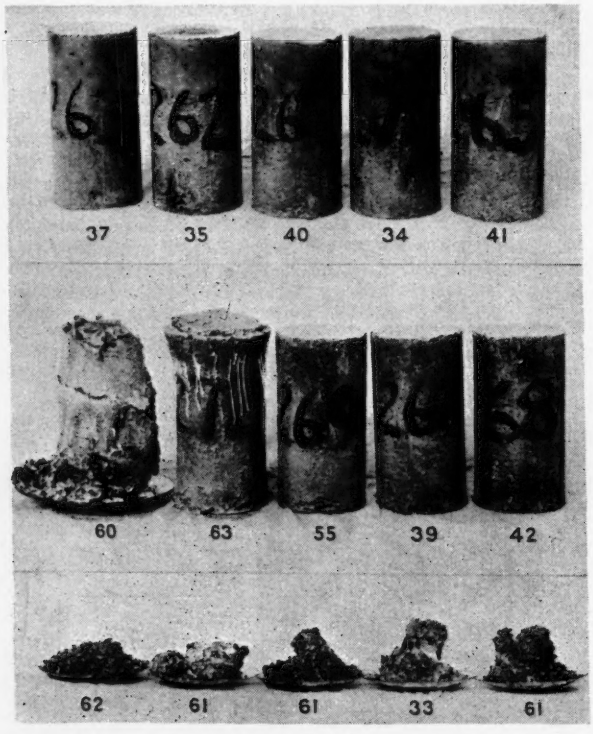


Fig. 3. One representative cylinder from each of the fifteen series upon which are based the graphs of Fig. 2 after 15 months in one per cent solutions of Na_2SO_4. These cylinders were identical when made except that different brands of standard portland cements, with laboratory numbers as indicated, were used. At 32 weeks the series with cement 62 tested 31 per cent of normal strength, while at one year the series with cement 41 tested 101 per cent. The other cements gave results between these extremes

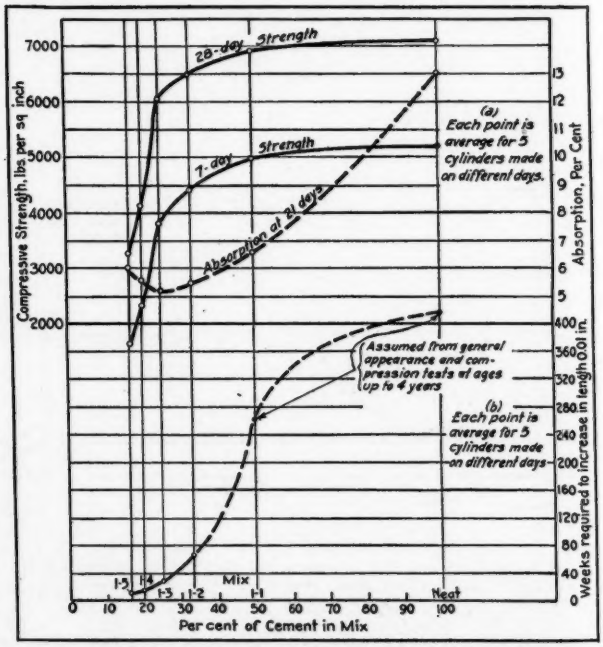

28-day Strength
7-day Strength
Absorption at 21 days
(a) Each point is average for 5 cylinders made on different days.
Assumed from general appearance and compression tests at ages up to 4 years
(b) Each point is average for 5 cylinders made on different days
Compressive Strength, lbs. per sq. inch
Absorption, Per Cent
Weeks required to increase in length 0.01 in.
Mix
Neat
Per cent of Cement in Mix

Fig. 4. Influence of mix on (a) strength and absorption of concrete and (b) effect from one per cent solutions of Mg SO_4.—Series 8-16-20

specimens should be stored in each jar and the specimens should be subjected to close visual examinations at intervals for a period of six months.

Briquettes made and stored under the conditions outlined should show but little evidence of disintegration, to the extent perhaps of a slight rounding of the edges, at six months if the cement used is of average resistance. More than slight evidence of action on briquettes in either solution should be grounds for rejecting the particular cement for use in alkali soils. Briquettes made of cements very low in resistance, when subjected to this test, will have almost completely disintegrated at six months.

The value of the test as outlined will be greatly increased if briquettes made of several different portland cements be included so that at all times a basis may be had for comparing the behavior of different cements under identical exposure conditions. Probably no fewer than five cements should run simultaneously, and a larger number is desirable, for in a group test the greater the range in resistance of briquettes made of different cements, the more evident will be the failure of any cement that falls well below the average.

In this paper the resistance of high alumina cements has been considered only very incidentally. It will be said though that, in general, experiments in the laboratory[1] have indicated that apparently under all conditions they have much greater resistance to sulphate waters than have any of the portland cements.

2. Quantity of cement used in the mix. The richer the mix the more resistent the concrete, other factors being the same. It is, however, only when the mix becomes richer than 1:2 that outstanding results are to be obtained in this manner, so that improvement so gained must necessarily be at considerably increased cost, and especially is this true when high resistance is required, as the greatest value of enriching the mix is not realized until it becomes as rich as 1:1. These points are illustrated by the curves of Fig. 4.

3. Quality of the concrete as measured by the 28-day compression strength. This is a matter that will not be gone into in any detail in this paper but, in general, all factors being the same, the concrete with the highest 28-day compressive strength is the most resistant. However, the value of such a test for alkali resistance has its limitation as it in no way indicates the difference in cements (see Fig. 2) nor does it give any indication of the comparative resistance of concrete cured under different conditions. This latter point is clearly brought out in Series 21—25 of the group of cylinders upon which Fig. 5 is based, as the order of these series in alkali resistance has been 22, 21, 24, 25, and 23, while that of the 28-day compressive strength was 23, 24, 25, 22, 21. To make this clearer Table I is inserted for consideration along with Fig. 5.

4. Conditions under which the concrete is cured. That concrete may develop maximum resistance to soil alkalies careful consideration must be given the curing. It has been found that by merely varying curing conditions cylinders identical in all other ways show a wide range of resistance. This point has already been developed in part in the preceding paragraph in which attention was called to Fig. 5 showing the remarkable results obtained by curing cylinders in steam in a temperature of 212 degrees Fahrenheit as compared with water curing. The value of long air hardening subsequent to the curing period in moisture is illustrated in Fig. 6 based upon ten series in which the air hardening period preceding exposure to the solutions has ranged from naught to forty-nine weeks.

In connection with the results of the curing experiments illustrated in Figs. 5 and 6, it is of particular interest to note that the cements used in both these groups were the same brands as cement No. 61 which made such a very poor showing in comparison with several other brands as indicated in Figs. 3 and 4. It therefore seems reasonable to conclude that by properly curing concrete made of high resistant cement that extremely resistant concrete can be produced, in many cases, at little or no increased cost.

RECOMMENDATIONS

For concrete to be exposed to the action of sulphate waters the foregoing may be reduced to the following recommendations:

1. Make a laboratory test of the cement for resistance in accordance with the routine as suggested in this paper. By so doing cements very low in resistance may be rejected thereby certainly eliminating, at no additional cost, early failures of well made concrete almost regardless of exposure conditions. Only those cements of average, or above average, resistance should be considered where the soil or water conditions are known to be bad.

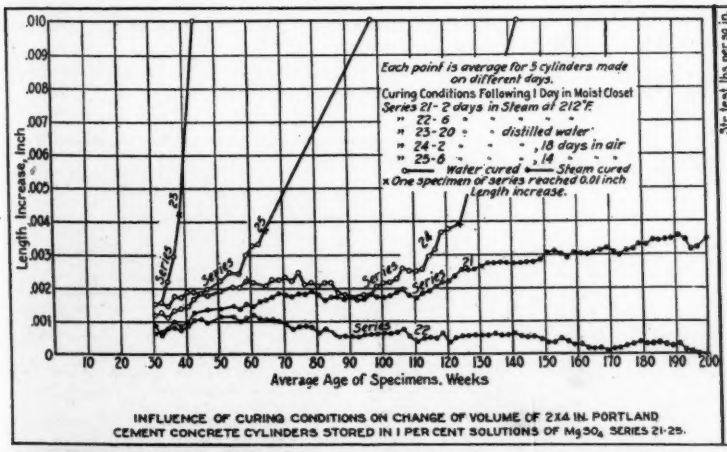
2. Where the work is of sufficient importance to justify the cost specify a mix of 1:2 or even 1:1 with portland cement and 1:4 or 1:3 with high alumina cement.

(Continued on page 43)

Table I. Curing Conditions, 28-Day Strength, and Order of Resistance to Alkali of Cylinders in Series 21-25 on which the Graphs of Fig. 5 are Based

Series No.	Curing conditions	28-day comprehensive strength, lbs. per sq. in.	Order of resistance to alkali
21	2 days in steam at 212° F.	3330	2
22	6 days in steam at 212° F.	3490	1
25	6 days in distilled water	4160	4
24	2 days in distilled water	4470	3
23	20 days in distilled water	4750	5

[1] Alumina Cements and Sulphate Water. "Concrete," Vol. 28, No. 4, April, 1926.


Each point is average for 5 cylinders made on different days.
Curing Conditions Following 1 Day in Moist Closet
Series 21- 2 days in Steam at 212°F.
" 22- 6 " " " " "
" 25-20 " " distilled water
" 24-2 " " " ,18 days in air
" 25-6 " " " ,14 " "
Water cured — Steam cured
x One specimen of series reached 0.01 inch Length increase.
Length Increase, Inch
Average Age of Specimens, Weeks
Series 23
Series 24
Series 25
Series 21
Series 22

INFLUENCE OF CURING CONDITIONS ON CHANGE OF VOLUME OF 2X4 IN. PORTLAND CEMENT CONCRETE CYLINDERS STORED IN 1 PER CENT SOLUTIONS OF $MgSO_4$ SERIES 21-25.

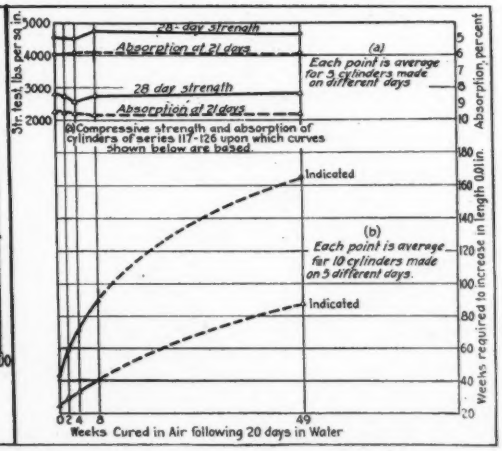

28-day strength
Absorption at 21 days
(a)
Each point is average for 5 cylinders made on different days
28 day strength
Absorption at 21 days
Compressive strength and absorption of cylinders of series 117-126 upon which curves shown below are based.
Indicated
(b)
Each point is average for 10 cylinders made on 5 different days.
Indicated
3 hr. test, lbs. per sq. in.
Absorption, per cent
Weeks required to increase in length 0.01 in.
Weeks Cured in Air following 20 days in Water

Fig. 5. (Left) Manner of curing has a marked effect on alkali resistance. Fig. 6. (Right) Influence of air curing on the life of concrete and Ottawa sand mortar cylinders stored in one per cent solutions of Na_2SO_4. Circular points denote the concrete, and triangular points the Ottawa sand mortar. This effect, shown at (b), may be compared with physical properties shown at (a).—Series 117-126.

Wisconsin's Safety With Explosives Campaign*

By John Swenehart

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and W. A. Rowlands

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THE Wisconsin safety-with-explosives special is a new type of demonstration designed to show in a spectacular way how Wisconsin uses explosives safely for agricultural development.

Wisconsin farmers and settlers now use annually about three and one-half million pounds of explosive. Actually 30,000 blasters throughout the state use these explosives. A few men are new to the use of explosives and due to a wholesome fear for the product they are handling, follow strictly safe regular practices. Others and by far the greater number are more experienced. Through constant use the danger side has somewhat worn off. It is easy for them to become lax in methods. Generally a blaster works alone in a field. There is no one to check him up on slip-shod methods. "Familiarity breeds contempt" and so called "short cuts" are taken which prove disastrous.

The safety-with-explosives special made a tour of the entire state, particularly where explosives are used in any considerable quantity. The methods and practices he uses are those which have been developed through Wisconsin's ten years of organized land clearing by the university and other agencies. Many kinks and easily applied practices are a part of the story, all of which is told in an understandable way. Primarily of course his purpose is to show the public the relation between effective method and safety to get results.

The exhibit consists of a motor truck of 1½ tons capacity on which is mounted a specially built panel body. The panels are painted with a series of paintings illustrating the story of safety and efficiency in the use of explosives. This truck carries all tools and equipment needed in the actual blasting work on stumps, stones and ditches. It serves as a basis of operation for roadside demonstrations which are interspersed with field demonstrations. The mobility of this exhibit makes it operative over a long period each day. People see it at the demonstration, on the road, passing through towns and villages, and when parked in towns over night.

The actors in this story are "Pyrotol Pete" and the "Kid". Pyrotol Pete is dressed in a costume consisting of a stag shirt, stag trousers and Scotch cap, all typical woods clothes. The cap carries the name "Pyrotol Pete" in brown letters and the shirt an outline of a pair of cap crimpers on one sleeve and an outline of a white pine stump on the other sleeve. The cap crimper, an essential part of the dress, is securely tied to the belt by means of a red handkerchief. The "Kid", Pyrotol Pete's assistant, is dressed similarly to Pyrotol Pete. He assists in the demonstrations and in keeping the equipment and the truck in good condition. For roadside demonstrations, the truck itself is on exhibit and object lesson and special large sized dummy cartridges, fuse, caps and cap boxes are used as illustrative material.

As a special means to aid blasters in following methods which promote safety and efficiency with explosives, two new features have been introduced and made a part of the demonstration.

Purchasing cap boxes and cap crimpers for distribution throughout the state to those visiting the special may seem to be strictly irrelevant to the business of a state university. Yet on the basis of Wisconsin's public welfare this was considered good business and carte blanche for the scheme was granted.

Over six hundred small wood cap boxes were made up and distributed at cost to those attending the demonstrations. These boxes hold twenty blasting caps and can be easily handled. (The boxes were simply made of two pieces of wood with twenty holes bored in the base and hinged with two small hinges.)

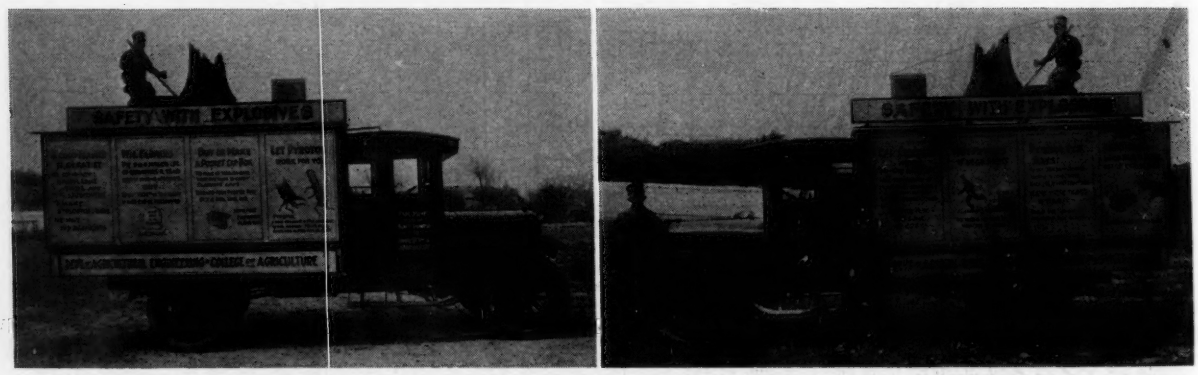
Several hundred cap crimpers were salvaged at half price and distributed at cost. The distribution of both cap boxes and cap crimpers were made distinctly a part of the special and could be obtained only from Pyrotol Pete at the close of the demonstration. A special form of receipt blank was issued with the sale of each cap box and crimper, making the purchaser a cooperator with the University in this safety campaign.

Smoking while blasting is common, especially when a blaster is working alone in a field. In order to draw attention graphically to this bad practice, a panel was built and a plug of chewing tobacco was actually fastened to a sign, reading "If you must use tobacco, have a chew." Thus, positively stated, we do not ask the blaster to stop doing something he has been in the habit of doing, but suggest the need for eliminating the practice of smoking when blasting. Many already have claimed this sign "did the trick." The invitation to "have a chew" has made it necessary to replace the tobacco every few days, but it has won over to safe practices many men ordinarily hard to reach. This trivial detail is just one of the important "dramatics" much needed to put over an idea in extension work.

By far the most important point in blasting practice

(Continued on page 43)

*Paper presented at the 20th annual meeting of the American Society of Agricultural Engineers, at Lake Tahoe, Calif., June, 1926.



Two views of Wisconsin's safety-with-explosives special on a 5,000-mile tour of the state

Research in Agricultural Engineering

A department conducted by the Research Committee of the American Society of Agricultural Engineers

Kinematics and Dynamics of the Wheel Type Farm Tractor*

II. Dynamics—Locating the Center of Gravity

By E. G. McKibben

Mem. A.S.A.E. Junior Agricultural Engineer, University of California

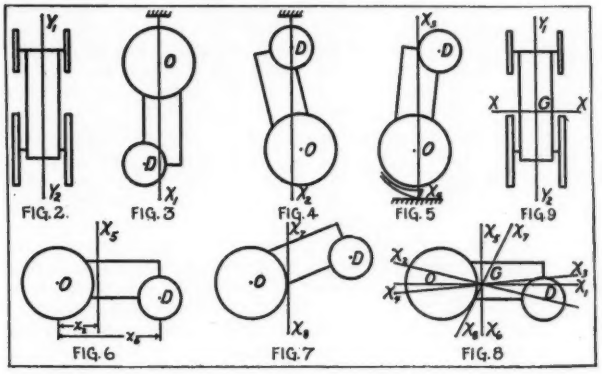
IF THE dynamics of a tractor are to be investigated in any position except with the plane of the wheel base horizontal, it is very desirable, in fact almost essential, to know the location of the center of gravity. Since most tractors are composed of many comparatively irregularly shaped parts, it is rather difficult to find the center of gravity of an assembled tractor mathematically, although in case of a new design the center of gravity should be located mathematically before construction is started. However, the center of gravity may be located rather easily experimentally.

Most tractors are at least approximately symmetrical with

*Second of a series of seven articles. The first installment appeared in the January issue. The third article of this series, entitled "Dynamics—External Forces," will appear in the March issue of AGRICULTURAL ENGINEERING. The material presented in these articles was obtained as the result of an agricultural engineering project conducted at the agricultural experiment station of the University of California. It has been edited and approved by the Research Committee of the American Society of Agricultural Engineers.

Notation of Fig. 10

D, center of front wheel
E′, point where vertical line through D strikes soil surface
G, approximate location of center of gravity
G′, point where vertical line through G strikes the soil surface
O, center of rear wheels
Q, point where vertical line through O strikes the soil surface
b_4, angle between d_6 and a line parallel to the wheel base
b_{12}, angle between d_{12} and line parallel to wheel base
d_6, distanee between O and G
d_{11}, distance between O and Q
d_{12}, distance between O and D
d_{13}, distance between D and E′
d_{14}, $d_{12} \cos b_4$ = wheelbase
x_2, distance between Q and G′
x_6, distance between Q and E′
x_7, distance between D and E′
z_3, angle between wheelbase and soil surface



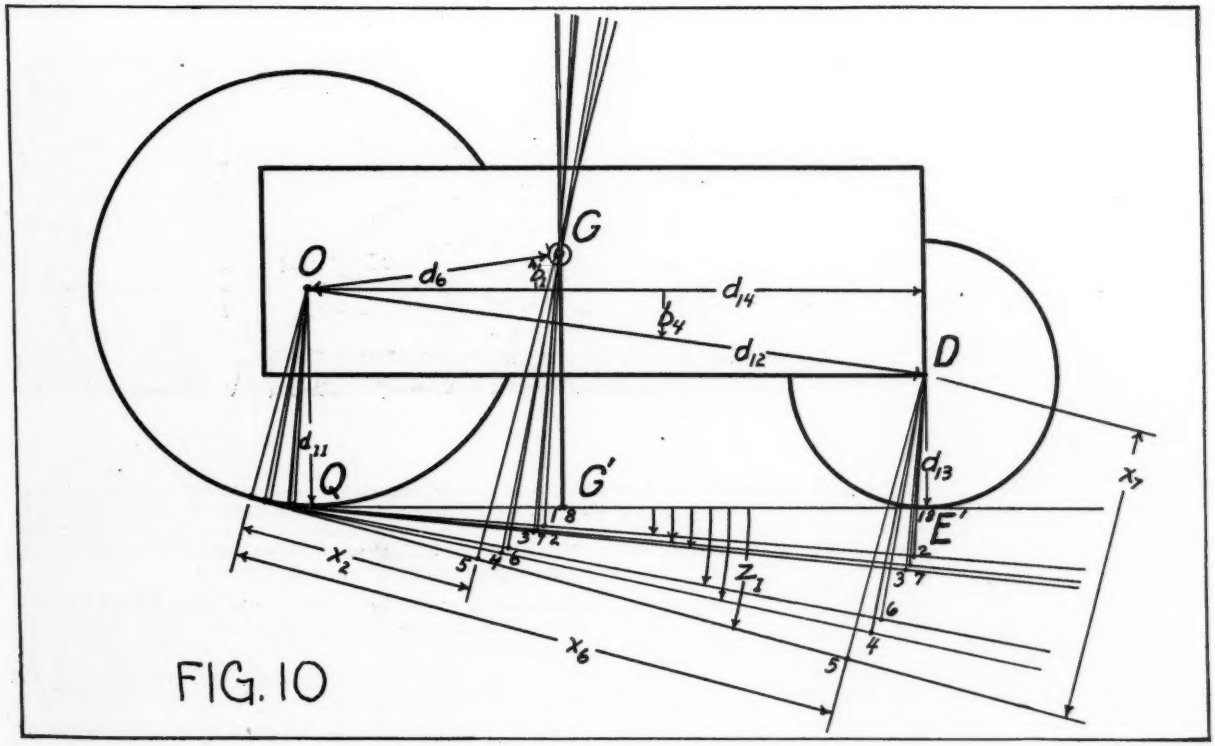


Table I.

Length d_{11} = 23.00 inches
Length d_{12} = 65.66 inches
Length d_{13} = 14.00 inches
Length d_{14} = 65.00 inches

Angle b_4 = —7.9°+
Total weight (W)—
Taken before studies = 4078 pounds
Taken after studies = 4080 pounds
Average = 4079 pounds

No.	1	2	3	4	5	6
	Height of D —inches	Weight on rear wheels—pounds	Angle (b_4+z_1) —degrees	Angle z_1 —degrees	x_6 —inches	x_2 —inches
	(x_7)	(W_1)	$\sin^{-1}\left(\frac{x_7-d_{11}}{d_{12}}\right)$	$(b_4+z_1)-b_4$	$d_{12}\cos(b_4+z_1)$	$x_6-\left(\frac{W_1x_6}{W}\right)$
1	14.000	2412.5	—7.9+	0.0	65.60	26.56
2	18.500	2432.0	—3.9+	4.0	65.50	26.45
3	20.250	2455.5	—2.4—	5.5	65.60	26.11
4	27.750	2492.5	+4.1+	12.0	65.49	25.48
5	32.125	2532.5	+8.0+	15.9	65.02	24.66
6	26.250	2496.0	+2.8+	10.7	65.58	25.46
7	20.125	2452.0	—2.5—	5.4	65.59	26.22
8	14.000	2407.5	—7.9+	0.0	65.00	26.64

respect to a vertical plane perpendicular to the axles and cutting the axles midway between the wheels. (See Y_1Y_2 of Fig. 2.) Therefore, the center of gravity will be somewhere in this plane. In fact, if the center of gravity is not in this plane, the tractor is not properly designed, for unless the center of gravity is in this plane the drivewheels will be supporting unequal weights and will therefore possess unequal tractive ability, when operating on a level field.

If the tractor is suspended from the rear axle, the center of gravity will be somewhere in the vertical plane passing through the center line of the rear axle. (See OX_1 of Fig. 3.) Likewise, if the tractor is suspended from the front axle, the center of gravity will be in plane DX_2 of Fig. 4. Also, if the tractor is balanced over some point of its frame such as the point, X_4, of the fenders (See Figs. 5 and 11) the center of gravity will lie in the vertical plane X_3X_4 through this point, X_4. The location of these planes may be easily determined by a plumb bob, and conveniently recorded on the side of the tractor with chalk.

A vertical plane, parallel to the axles, containing the center of gravity may also be obtained by determining the weight at the front and rear wheels for a given position of the tractor, and substituting in the following formula:

$$x_2 = \frac{W_2}{W} x_6 \text{ (See Fig. 6)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

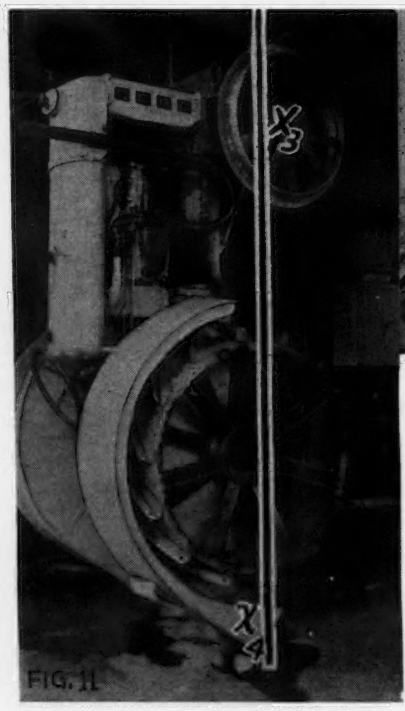
Where x_2 = horizontal distance of plane X_5X_6 from O,
x_6 = distance between vertical lines through points D and O
W = weight of entire tractor
W_2 = weight at D

Placing the tractor in another position, another plane X_7X_8 (See Fig. 7) also containing the center of gravity may be located by the same method.

Thus the center of gravity, G, is located by the intersection with plane Y_1Y_2 of the line of intersection of any two of planes OX_1, DX_2, X_3X_4, X_5X_6, and X_7X_8 (See Figs. 8 and 9).

A check test of the last mentioned method of locating the center of gravity was made with the apparatus, shown in Fig. 12, which consisted of a tractor, wagon scales, crane, straight edge, spirit level, and three-foot rule. This study

(Continued on page 43)



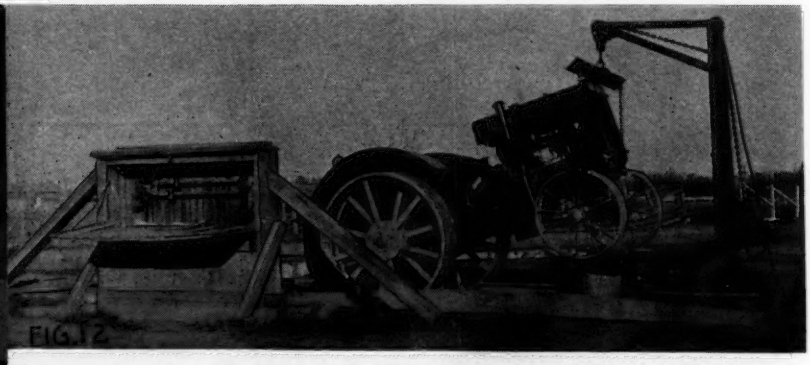


Fig. 11. (Left) Entire weight of tractor supported by and balanced over the points of the fenders. (The chain did not support any of the weight of the tractor but was passed loosely around the beam and the front axle as a precaution against the accidental falling of the tractor.) Note the vertical line X_3X_4 which locates a vertical plane, parallel to the axles, containing the center of gravity

Fig. 12. (Above) Locating the center of gravity of a tractor by determining the weight at the rear wheels for different positions

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Effects of Soil Treatments on the Draft of Plows, F. L. Duley and M. M. Jones (Soil Science, Baltimore, Md., 21 (1926), No. 4, pp. 277-288, figs. 4).—Dynamometer tests conducted at the Missouri experiment station on nineteen different plats of silt loam soil that had received different rotation and manurial treatments during the past thirty-six years are reported.

Heavy manuring had little effect on the draft of plows, but in general seemed to have a tendency to increase it. The unmanured soils usually worked down into a more friable seedbed condition than did the manured soils. Chemical fertilizers, even in heavy applications, did not increase the plow draft, and seemed to give slightly lower results than were obtained on manured soils. The draft tended to increase as the soil moisture decreased where the measurements were made under fairly satisfactory plowing conditions. Manured soil contained more moisture than unmanured soil.

Rural Electric Development in Alabama, E. C. Easter (Committee on the Relation of Electricity to Agriculture Bulletin, Chicago, 2 (1926), No. 5, pp. 12, figs. 4).—A summary of results of two years' field investigations conducted by the Alabama experiment station on the use of electricity on Alabama farms is presented. The greater part of the data so far deals with the amount of electricity utilized for different purposes.

Surface Action and Fluid Film Lubrication: Some Film Thickness Measurements, A. E. Becker (Industrial and Engineering Chemistry, 18 (1926), No. 5, pp. 471-477, figs. 17).—Studies are reported which showed that to obtain fluid film lubrication there must be adequate adhesive forces between the lubricant and the bearing surfaces. This indicates four general types of bearing combinations. An apparatus for measuring the film thickness developed is described, and data for four oils and four bearing combinations are reported.

The general equation for film thickness in terms of load, speed, and viscosity is found to be

$$t = K\ 1-\frac{\log P}{A}\ 1-\frac{\log S}{B}\ 1-\frac{\log \pi}{C}$$

in which K, A, B, and C are constants depending upon surface action forces, P is the load, S is the speed, and π is the absolute kinematic viscosity.

Rammed Earth Walls for Buildings, M. C. Betts, and T. A. H. Miller (U. S. Department of Agriculture, Farmers' Bulletin 1500 (1926), pp. II + 26, figs. 22).—Practical information on the use of rammed earth for building construction is presented, the greater part of which has been abstracted from accounts of experimental work in England.

Mechanical Conservation of Organic Manures, E. Berendt (Mechanische Konservierung des Organischen Dungers. Neudamm: J. Neumann, 1925, pp. 86, pls. 3, figs. 20).—This a handbook of information on the construction of liquid and solid manure pits, compost pits, and sanitary cow stables.

Roof Coverings: Their Manufacture and Application, E. G. Blake (New York: D. Van Nostrand Co., 1925, pp. XI + 264, figs. [143]).—This book describes the origin, nature, and the methods of preparing the various materials and substances that are employed for covering the roofs of all classes of buildings. It contains chapters on the character and properties of a roof covering, thatch, organic roof coverings, metallic coverings, mineral coverings, manufactured mineral coverings, asbestos cement, bituminous felts, asphalt, glass, and cement concrete.

Relation of the Manner of Failure to the Structure of Wood Under Compression Parallel to the Grain, J. L. Bienfait (Jour. Agr. Research [U. S.], 33 (1926), No. 2, pp. 183-194, figs. 6).—Studies conducted by the U.S.D.A. Forest Service are reported which showed that slip lines, or slip planes, are the first indication of injury in compression parallel to the grain, but it is doubtful whether they are likewise produced in tension along the grain.

The early or initial failures, consisting principally of numerous localized slip planes, show no such distinctive difference between their radial and tangential aspects as that exhibited by gross failures. Apparently, however, they are sources of zones of weakness within which the buckling of the fibers resulting in gross failures may start more easily than elsewhere.

The gross failure in compression parallel to the grain consists of a buckling of the fibers. The least amount of friction between fibers occurs when the plane of buckling or failure is inclined. The inclination of the failure occurs as a rule in a tangential direction. The only probable explanation of this behavior is that the medullary rays increase the resistance to buckling in a radial direction, thus causing the line of failure to be inclined on the tangential surface.

Oil Flow in Plain Bearings, D. P. Barnard, IV (Industrial and Engineering Chemistry, 18 (1926), No. 5, pp. 460-462, figs. 6).—This paper describes a simple method of developing the approximate laws controlling oil flow through bearings due both to the pressure developed in the film and to oil feed pressure, and presents some experimental data in substantiation of this method.

Relation of Water to Yield of Crop (Montana Station Report 1925, pp. 19, 21).—Data are briefly reported which showed that the largest number of irrigations and the maximum amount of water applied gave the largest acre yield of alfalfa, but the yields were in no way proportionate to the amount of water applied. The time of application of the water was also an important factor. The yield of wheat was found to have little relation to the amount of water applied.

Heat Transfer and Evaporation, W. L. Badger (New York: Chemistry Catalog Co., 1926, pp. 306, figs. 113).—This book is intended for research workers in heat transfer and evaporation as well as for engineers designing and operating evaporating systems. It contains chapters on general theory of heat transmission—conduction and radiation; heat transfer by convection—general; heat transfer between solids and gases, solids and liquids, and between solids and condensing vapors, especially steam; heating and heater design; evaporator bodies; heat transfer in evaporators; theory and calculations for multiple-effect evaporators; multiple effect operation; evaporator auxiliaries; evaporators as applied in specific industries; and costs.

Small Concrete Construction on the Farm, M. C. Betts and T. A. H. Miller (U. S. Department of Agriculture, Farmers' Bulletin 1480 (1926), pp. II + 38, figs. 37).—Descriptions of sound methods of building a few simple concrete structures useful on the farm are given.

Ultra-Violet Spectroscopy of Flames of Motor Fuels—Preliminary Experimental Survey, G. L. Clark and W. C. Thee (Industrial and Engineering Chemistry, 18 (1926), No. 5, pp. 528-531, figs. 2).—Preliminary studies conducted at the Massachusetts Institute of Technology are reported in which the ultra-violet spectra were photographed of the detonation, explosion, and combustion flames in an engine of several commercial brands of gasoline, of gasoline containing butyl nitrite, a detonation inducer, tetraethyl lead, a detonation suppressor, and of benzene and alcohol.

The spectra of detonation, explosion, and combustion were found to be different, the first being characterized by a strongly banded structure. Both tetraethyl lead and butyl nitrite were found to affect the spectra. The former suppressed the strong bands and shortened the ultra-violet, while the latter even accentuates the intensity in the far ultra-violet, thus throwing some light on the radiation theory of detonation control.

The strong lead lines and the absence of lead compound bands showed that the metallic lead atoms or the process of decomposition of the tetraethyl lead molecule is the effective agent in the reaction propagation, and that combination with the bromine introduced as ethyl bromide takes place subsequently to the oxidation reaction. The copper lines from the plug spark appeared as emission lines in the presence of lead in the vapor, but as absorption lines in its absence.

The results in general are considered to be sufficiently important and clear to warrant thoroughly quantitative investigation with the spectroscope data correlated with known composition of fuels, pressures, reaction rates, and amounts of detonation.

Yoking Oxen to the Plow: A New System, W. S. H. Cleghorne (Union of South Africa Department of Agriculture Scientific Bulletin 53 (1926), pp. 14, figs. 12).—Experiments conducted at the Potchefstroom Experiment Station are reported, the purpose of which was to develop methods and yokes for the yoking of oxen to prevent sidedraft in single and gang plows.

The results showed that the formula $Di = 6 + (n + 1)\ W$ can be used for calculating the proper width of yokes between skeys for different types of plows. In this formula Di is the width of yoke between skeys, n is the number of plow bottoms, and W is the width of cut of each plow bottom.

The Principles and Practice of Surveying.—II, Higher Surveying, C. B. Breed and G. L. Hosmer (New York: John Wiley & Sons; London: Chapman & Hall, 1926, vol. 2, 3. ed., pp. XVIII + 489, figs. 184).—This is the third edition of this handbook which deals with higher surveying and is chiefly devoted to a consideration of the various methods of conducting topographic and hydrographic surveys. The subject matter is divided into the control of the survey, filling in topographic details, hydrographic surveying and stream guaging, and constructing and finishing maps.

Electric Plowing, R. B. Matthews (Engineering [London], 122 (1926), No. 3161, pp. 211-214, figs. 23).—A critical analysis of the important features of electric plowing is presented.

Character of the Groundwater Resources of Arizona, C. N. Catlin (Arizona Station Bulletin 114 (1926), pp. 173-293).—Analysis of a large number of samples of the ground waters of Arizona are presented and discussed, with particular reference to their value for sanitary and irrigation purposes.

Septic Tanks for Farm Sewage Disposal, F. L. Cooper (College of Agriculture, Colorado Extension [Bulletin] 247-A (1926), pp. 16, figs. 8).—Practical information on the planning and construction of small sewage disposal systems for Colorado farms is presented.

Lime for West Virginia Farms, D. R. Dodd (West Virginia Station Bulletin 215 (1926), pp. 24, figs. 16).—Practical information on the use of lime on West Virginia farms is presented, including a description of a homemade lime spreader, lime pulverization, and lime burning. Working drawings for a lime kiln are included.

Farm Water Supply and Sewage Disposal in West Virginia, F. D. Cornell, Jr. (West Virginia Station Bulletin 206 (1926), pp. 27, figs. 23).—Studies of the sanitary conditions on 287 farms in three West Virginia counties are reported. Of the farms visited, sixty-six could have had the convenience of running water in the house by merely piping the water direct. Cisterns seemed to be growing in popularity as a source of water supply, but not enough attention was being paid to filtering properly the cistern water used for drinking purposes.

On 124 farms the open back privy was in use, ninety others were built on the surface closed at the rear, and on 21 farms there were no privies at all. No septic tank privies were found, and only 44 farms had pit privies.

Where bath equipment was found the effluent was either drained out on the surface of a field or into a nearby creek. No septic tanks were found, although the need for them was apparent.

Graphic Representation of the Kopecky Soil Classification Scheme for Technical Purposes, E. C. Doerell (International Review of the Science and Practice of Agriculture [Rome], n. ser., 4 (1926), No. 2, pp. 307-311, figs. 3).—A graphical representation of the Kopecky soil classification scheme is presented for the purpose of establishing distances between drains in soils. This soil classification scheme is brought into a system of sectors of a circle. The circumference of the circle is divided into 80 parts for the percentage content of the soil fraction with a diameter of less than 0.01 mm. On the radius the proportion of fraction II is drawn to contents of 40 per cent. The sectors so formed represent the types of soil. The direct reading, which corresponds to the distance between drains suitable to the mechanical composition of the soil as determined by analysis, can be taken from the graph with the compasses or any other aid. Curves are also given for the determination of distance between drains in layers of soil of varying permeability.

The Influence of the Environmental Temperature on the Heat Production of Cattle, E. B. Forbes, W. W. Braman, M. Kriss, J. G. Fries, D. C. Cochrane, C. D. Jeffries, R. W. Swift, R. B. French, and J. V. Maucher, Jr. (Journal of Agricultural Research [U. S.], 33 (1926), No. 6, pp. 579-589).—It is reported that a recent review and recalculation of published energy metabolism work of the Institute of Animal Nutrition of the Pennsylvania Agricultural Experiment Station has brought to light the fact that in one experiment at least, and perhaps in others, there was a confusion of heat produced from the feed with heat produced from the katabolism of body tissue by reason of the fact that the shearing of the steer which served as the experimental subject had the effect of raising the critical temperature for the animal above the temperature of the chamber of the respiration calorimeter.

A steer receiving as much as 2.933 kg. of dry matter of feed per day may find a temperature of 19 degrees Centigrade below its critical temperature if the animal has been sheared.

In a fasting experiment with a steer, beginning four days after the last feed was given, the heat production on the first day of observation, that is, on day four or five after feeding, was found to represent essentially the true fast.

In the case of a fasting steer, shorn of its coat of hair, weighing 339.6 to 330.5 kg., at environmental temperatures of 13.68 degrees, 15.7 degrees, 18.26 degrees, and 22.06 degrees Centigrade, the 24-hour heat production was, respectively, 8,243 calories, 7,989 calories, 7,519 calories, and 6,806 calories, showing that at least the first three temperatures were below the critical for this animal.

With a fasting steer carrying a full coat of hair, weighing 356 to 349 kg. and exposed to environmental temperatures of 15.54 degrees, 18.46 degrees, 21.51 degrees, and 14.16 degrees Centigrade, the corresponding 24-hour heat production was 6,322 calories, 6,430 calories, 6,453 calories, and 6,180 calories, respectively, at least the first three temperatures being above the critical. The data suggest that at these temperatures there may have been a slight expenditure of energy by the animal in keeping cool.

With both the shorn steer and the steer with a full coat the percentage of the heat emission as latent heat of water vapor increased with the increase in temperature, this effect being much more pronounced with the steer having the full coat of hair. Conversely, the percentage of the heat emission lost by radiation and conduction (combined) decreased with increase in the temperature.

The average heat production of a fasting steer with its full winter coat was 18.01 calories per kilogram of live weight and 1,457 calories per square meter of body surface. The decrease of heat production per degree centigrade of rise in temperature below the critical was 36 calories per square meter of body surface, or about 2.5 per cent of the fasting katabolism.

Motor Plowing Tests With Monopolin and Benzol, F. Fritz (Technikin Landwirtschaft, 7 (1926), No. 7, pp. 45-47).—Plowing tests with tractors and motor plows under as nearly as possible identical conditions to compare an alcohol-benzol mixture with straight benzol for fuel are briefly reported.

In all cases more of the mixed fuel was used than of the straight benzol, but this was apparently more than compensated for by the lower cost of the mixed fuel. The estimation of fuel consumption on the basis of time was found to be erroneous. This should be based upon area plowed or upon volume of soil turned.

The conclusion was drawn that fuels consisting of mixtures of alcohol with more volatile materials such as benzine or benzol may be successfully used in tractor plowing.

Some Little Understood Factors Affecting Lubrication, E. G. Gilson (Industrial and Engineering Chemistry, 18 (1926), No. 5, pp. 467-470, figs. 12).—Studies are reported which showed that changes in friction can not always be satisfactorily explained by changes in viscosity of the oil due to a change of its temperature. Oil film friction is shown to be influenced by a change of one of the metals between which the film is working and also by changing from an oxidizing to a nonoxidizing atmosphere. It is demonstrated by means of a complete bearing within an inclosure how the friction is affected by the atmosphere surrounding the bearing.

It is concluded that the facts shown cannot be explained by the viscosity-temperature changes of the oil, and it is suggested that efficient lubrication may depend upon a reaction between the metals of the bearing and the oil, the nature of which is influenced by the atmosphere in which the bearing is operated. The reaction seems to be accelerated when both oxygen and moisture are present.

Properties of Refrigerants, H. D. Edwards (Amer. Soc. Refrig. Engin. Circ. 2 (1926), pp. 24, figs. 20).—A compilation of data is presented on the properties of different refrigerants, dealing especially with physical properties, effect on various lubricants, toxicity, inflammability, explosive qualities, method of testing purity, and precautions essential in handling.

Land Clearing in Alabama Bottom Lands, R. Godwin (Alabama Station Circular 50 (1926), pp. 8, fig. 1).—The results of experiments are reported which showed that when the cost of explosive is the same per pound the final cost of removal per stump is not in proportion to the diameter. The cost per stump was nearly doubled for each increase of 3 inches in diameter.

Studies on the effect of soil conditions on blasting efficiency showed that when the soil was loose, friable, and soft, and had a low free water content the blast was forced into the earth by the heavy rooted hardwood stump above. An extra large charge heaved the soil through the roots and left the stump intact, indicating that the force of the blast compressed the soil on the bottom and sides of the shot hole. The loose soil sifted between the roots, leaving the stump in place with a large hole under it. With soil having a high free water content, the blast was found to meet positive resistance on the bottom and sides of the shot hole, due to the free water rendering it less compressible. The line of expansion of the blast was upward after a relatively small downward and lateral expansion. The wet soil held together and acted as a shoulder for the force of the blast to lift against.

Experiments on explosives showed that in dry land 20 per cent ammonia dynamite with a speed of 9,600 feet per second was too slow, since it blew the dirt from under the stump and left it practically in place. Sixty per cent dynamite with a speed of 16,000 feet per second was more satisfactory but was too fast, since it shattered the stump without removing it. The most satisfactory explosives were the 30 and 40 per cent dynamites having speeds of 12,000 and 14,000 feet per second, respectively. All of these explosives were satisfactory in wet soil. There was little or no difference in the performance of high counts of 30 and 40 per cent dynamites.

Experiments on the relation of stump diameter and size of charge showed that the load in pounds of high count dynamite necessary to remove green hardwood stumps from wet soil was equal to the square of the diameter of the stump in feet 14 inches from the ground plus 0.5.

Characteristics of Full and Partial Journal Bearings, H. A. S. Howarth (Industrial and Engineering Chemistry, 18 (1926), No. 5, pp. 453-460, figs. 18).—An analysis is presented of bearings bored with running clearance and bearings fitted carefully to the journal. The first type includes full or complete bearings, central partial bearings in which the line of action of the resultant load bisects the bearing angle, and offset partial bearings in which the line of action of the resultant load intersects the bearing surface usually more than half way from the leading edge.

Graphical studies of these types are reported, the purpose being to provide a complete set of fundamental laws which must govern the actual lubrication of all plain journal bearings. The bearing characteristics as given represent ideal conditions in that they show the maximum film thickness which may be realized for a given load. These laws may serve as a guide in the study of actual bearings in which such factors as end leakage and surface roughness play a modifying part and prevent the carrying power from being as great as in the ideal case.

The question as to the advantages of employing two or more pivoted segments instead of a single partial bearing to support a journal is cited as an example of the use of these laws. It is shown that the film is thinner in the case of the bearing of two segments, the total arc of each bearing and other conditions being equal. In a similar manner a three-segmented bearing is inferior to one of two segments.

Four Important Factors in the Manufacture of Concrete Pipe for Alkali Soils

(Continued from page 35)

3. Careful consideration should be given all factors which will produce the highest 28-day strength concrete with any given cement for any predetermined curing condition, for within these limitations the 28-day strength is a good indicator of resistance. This is particularly true when high strength is the result of a rich mix.

4. After the concrete is made, keep sulphate-bearing waters from intimate contact until the concrete has had an opportunity to dry and harden in air for the longest time practicable for the job at hand. The longer the concrete hardens the greater the resistance and this period should in no case be less than thirty days while ninety days or more is of great value. To develop greatest resistance steam cure when not less than twenty-four hours old in a temperature of 212 degrees Fahrenheit, or higher, for twenty-four hours, or longer. All these curing conditions are particularly applicable to the manufacture of concrete pipe and other pre-cast products.

Wisconsin's Safety With Explosives Campaign

(Continued from page 38)

demonstrated is the lighting of the fuse. Many otherwise good blasters continually have difficulty lighting the fuse with any degree of assurance. This results in delay and danger.

One farmer in a northern county, when he saw the poster at a cheese factory announcing the visit of Pyrotol Pete and the safety special, drove over thirty miles to ask Pyrotol Pete why someone somewhere didn't have sense enough to have manufactured a grade of fuse that can be lighted on a windy day without using up a full box of matches and wasting valuable time. He further stated that he had tried every known method of lighting fuse and firmly believed that the trouble was in its manufacture. "Yes," he said, "I'm an old man now, and I've used explosives for the last twenty-five years, almost every year. I've tried using fire brands, candles, lanterns, patent cigar lighters, and have even tried a blow torch. I nearly got killed once using a blow torch, too. I had lit the fuse but thought it was not yet lit."

Here Pyrotol Pete demonstrated lighting fuse the right way. Matches scratched on trousers rarely light fuse. Use a small stone held close to the end of the fuse so that immediately when the match ignites, the hot end spitting flame is pushed directly into the bed of powder in the fuse. Two seconds delay and the spit of the match is gone.

The farmer tried a few pieces of fuse that way. Then he laughed and said, "Pshaw, why didn't I think of that myself?"

Throughout the entire schedule nothing but positive, direct statements were made to those in attendance. The word "don't" was avoided. The value of the many direct appeals of this demonstration idea, however, have been repeatedly pointed out by blasters and others.

It was expected that the safety special would arouse a general public sentiment against carelessness which after all is essential to insure safe methods. Carelessness with explosives will not be tolerated by a public informed and alive to the fact that proper methods make explosives a safe and dependable force in agriculture.

Pyrotol Pete aimed to reach not only the blaster and his friends but the general public as well. Hundreds of column inches of press publicity and widespread public attention are following the 5,000-mile run of the Wisconsin's safety-with-explosives truck.

Kinematics and Dynamics of the Wheel Type Farm Tractor

(Continued from page 40)

was conducted with the tractor as shown, that is, without traction lugs, steering rims, or operator. The addition of these would in no way affect the method of procedure, although it would, of course, change the actual results. If a test were being made to obtain information on the location of the center of gravity of a specific tractor under specific working conditions, these items should be included. Since this study was for the purpose of justifying the method, they were omitted as a matter of convenience.

The data taken and results computed are given in Table 1 and Fig. 10. Lengths d_{11}, d_{13}, and d_{14} were measured and found to be 23, 14, and 65 inches, respectively. The tangent of angle b_4 is $\frac{d_{13}-d_{11}}{d_{14}} = \frac{14-23}{65} = \frac{-9}{65}$.

From tables of tangents, $b_4 = -7.9° +$

Also, $d_{12} = \frac{d_{14}}{\text{Cos } b_4} = \frac{65}{.9905} = 65.66$

The total weight of the tractor was taken both at the beginning and close of the study.

The weight supported by the rear wheels was obtained for different heights of the front axle. The heights of the front axle are recorded in column 1 of Table I, and the corresponding weight supported by the rear wheels are recorded in column 2. The value for (b_4+z_1), z_1, x_s and x_2 (See Fig. 10), which are recorded in columns 3, 4, 5 and 6, were computed by the formulas given at the tops of these columns. Fig. 10 is plotted to scale from the computed data of Table I. From Fig. 10 it is evident that for all practical purposes this method locates the center of gravity with sufficient accuracy. The method would be more accurate if larger values of the angle z_1 had been used. It should also be noted that the movement of fuel and oil due to the changing position of the tractor would prevent the vertical lines through G'_1, G'_2, G'_3, G'_4, G'_5, G'_6, G'_7 and G'_8 from being exactly concurrent at point G.

A large figure similar to Fig. 10 was drawn, using a scale of 1 inch = 2.5 inches; and b_4 measured to the nearest tenth of a degree and d_6 measured to the nearest tenth of an inch, with the following results:

$b_4 = 6.6$ degrees

$d_6 = 26.8$ inches

Therefore, (26.8) (cos 6.6) = (26.8) (.9923)—23 = 26.6 inches = distance of center of gravity, G, in front of center of rear axle, O.

And, (26.8) (sin 6.6) = (26.8) (.1184) = 3.2 inches = distance of center of gravity, G, above the center of the rear axle, O.

Thus it is possible for the designer, instructor or student to locate quite accurately the center of gravity of an assembled tractor by means of rather simple apparatus which is usually available at any manufacturing plant or educational institution.

EDITOR'S NOTE: The third article of this series, entitled "Dynamics-External Forces," will appear in the March issue of AGRICULTURAL ENGINEERING.

AGRICULTURAL ENGINEERING

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A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

PUBLICATIONS COMMITTEE
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The Society is not responsible for the statements and opinions contained in the papers and discussions published in this journal. They represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

RAYMOND OLNEY, Editor

A Bureau of Agricultural Engineering

DURING the past few years there has been a more or less expressed desire and hope on the part of agricultural engineers that the day might soon come when we would have a bureau of agricultural engineering in the Department of Agriculture at Washington. Many members of our Society who are in close contact with the work at Washington and with the Department of Agriculture in general have come to the conclusion that now is the time to let our wants be known.

I believe that practically all our members are acquainted with the fact that at present the work in agricultural engineering is conducted by a division in the Bureau of Public Roads. This may have been the proper organization some years ago, but each of these lines of work, namely agricultural engineering and highway engineering, have grown to such proportions that each merits the rank of a separate bureau without reference to the other.

The subject matter which the division now handles is so varied and covers such a wide field that it should be in several divisions instead of one. In fact, the subject matter of this one division is so varied and the work has grown to such proportions that it covers a field much greater than that covered by some existing bureaus.

There is every reason why the entire membership of the American Society of Agricultural Engineers should get behind this movement to establish a bureau of agricultural engineering in the Department of Agriculture. The replacing of the division by a bureau will add to the prestige of the agricultural engineering personnel at Washington, making its work there of greater value among the governmental agencies. This enhanced value will also be carried all along the line to the state colleges and experiment stations, to the departments of agricultural engineering and to the other organizations and individuals in any way connected with the work of agricultural engineering. The resolution which was prepared and sent to Secretary of Agriculture Wm. M. Jardine, by the officers of this Society, with the approval of the Council, is found elsewhere in this issue. It sets forth many good arguments in support of this movement. Every member has an opportunity to assist in one of the biggest jobs we have ever undertaken . Let us all get our energies back of it and put it across.

O. W. SJOGREN

President,
American Society of Agricultural Engineers

Huntington's Message Finds Favor Abroad

BELIEVING that it would be of interest and value to the recipients and react ultimately to the benefit of American agriculture and the agricultural engineering profession, the Secretary's office sent reprints of the paper presented by Arthur Huntington at the A.S.A.E. annual meeting at Lake Tahoe and published in the Journal for September, 1926, under the title "Agriculture Arrives at the Industrial Revolution," to a number of men prominent in educational, financial and legislative positions, such as the presidents and deans of land grant colleges, members of Congress, members of the agricultural commission of the American Bankers Association, Chamber of Commerce of the United States, etc. Of the letters received in response many were merely acknowledgments written before reading the article, but some offered comments after giving the article a careful reading. We are not at liberty to quote these persons specifically, but it seems proper to make a few anonymous quotations to show the trend and range of opinion which were stimulated:

"The facts given are pertinent, and the conclusions arrived at, I think, sound."

"There is one statement early in the discussion which strikes me; namely, 'No peasant type of farming can compete with American large scale production and no peasant type of mind can practice the American type of farming.' This statement is exactly in line with my own philosophy."

"My general feeling is that up to the present, in spite of the splendid inventions such as the grain harvester and other types of farm machines, the principal contribution which engineering has made as a science to agriculture is the increased application of power. I do not believe that we have to any similar degree developed the application of labor-saving devices that has been done in industry, but I do believe that we are now right in that era out of which will probably come fewer farms, fewer farmers and a tremendous social problem as all of this unskilled farm labor is released particularly the colored labor of the South."

"I would regret from a sociological standpoint to see American agriculture become as highly industrialized as Mr. Huntington stated it would become. Progress, however, in the industry undoubtedly lies in this direction."

"In the main, I am in hearty accord with Mr. Huntington's viewpoint, and in fact I do not know that I seriously disagree with him in any important particular."

"I should be interested in getting your reaction on how one could get such a splendid program before the average farmer."

"I consider this one of the best outlines of the present agricultural situation that has come to my attention, summing up in a masterly way the results and the lessons of many investigations and proposed remedies. The method he proposes will not satisfy those who are looking for agricultural miracles and expect to see their economic ills cured by the simple expedient of having someone look at their tongues and prescribe three doses a day from a dark brown bottle, but it will meet a hearty response from those who have made a careful study of the situation and recognize that agriculture must reorganize itself and bring its production per man to an equality with that in industry."

Engineers*

THERE are still a few moss-covered individuals who deny that there is any such profession as agricultural engineering. They are of the same type as those who in the past denied the existence in fact of electrical engineering, mining engineering and automotive engineering, and they will take the same position in the future in regard to chemical engineering. Agricultural engineering is of greater importance today than ever before and progressive men and institutions realize this evident fact.

*From an editorial in December 11 issue of the "Ohio Stockman and Farmer."

A. S. A. E. and Allied Activities

A.S.A.E. Recommends Bureau of Agricultural Engineering in U.S.D.A.

THE American Society of Agricultural Engineers, as the national society representing the agricultural engineering profession, is very much interested at this time in the proposal to create a separate bureau of agricultural engineering in the U. S. Department of Agriculture. The future development of agricultural engineering makes it imperative that such a bureau be established. The sentiment among the membership of the Society is overwhelmingly in favor of the organization of such a bureau. In order to give expression to the desires of the Society the following resolution has been approved by the Council and submitted to the Secretary of Agriculture, W. M. Jardine, recommending that the Department of Agriculture recommend to Congress the enactment of the necessary legislation to create such a bureau:

A Resolution Recommending That a Separate Bureau of Agricultural Engineering Be Created in the U. S. Department of Agriculture

WHEREAS there has developed steadily during a period of several years a firm conviction among the membership of the American Society of Agricultural Engineers that it is in the interest alike of American agriculture, of the agricultural engineering profession, and of the work in agricultural engineering conducted by the United States Department of Agriculture that agricultural engineering should be elevated to the rank of a separate bureau in the Department, and

WHEREAS this matter has been the subject of repeated discussion at meetings of the Society at which the following points have been cited and emphasized:

1. Agricultural engineering as a definite profession and as a substantial factor in the art and science of agriculture is about twenty years old, it has grown in importance and personnel until it is today one of the greatest single factors in efficient and profitable agriculture, and so publicly acknowledged by the foremost practical farmers in America.

2. Agricultural engineering is now recognized by the farm equipment, building materials, electric service and other industries supplying and serving the American farmers as the logical, competent, and established means of technical contact with the agricultural field. These industries, individually and through their associations, are working in extensive and continually increasing cooperation with the Society, the departments of agricultural engineering of the land-grant colleges and experiment stations, and the agricultural engineers of the Department of Agriculture.

3. In nearly seventy-five per cent of the land-grant colleges and experiment stations, agricultural engineering now ranks as a separate department. The fact that so large a proportion of the colleges have taken this action seems to demand similar action with reference to the federal agricultural engineering organization, in the interest of prestige, leadership and cooperative relationships.

4. The subject matter of agricultural engineering is in nowise subordinate to that of highway engineering and highway administration, nor have these latter subjects enough in common with agricultural engineering to justify any relation other than that of coordinate bureaus. However expedient from the standpoint of internal organization it may formerly have been to administer agricultural engineering as a division of the Bureau of Public Roads, both of these organizations have now grown to such proportions as to emphasize the incongruity of the present arrangement.

5. There is ample precedent for the change in status of agricultural engineering from a division to a bureau when demanded by the logic of the situation and the importance of the work. For example, such a change was made with respect to dairying even though it logically could be construed as a phase of animal industry. There is no such close relationship between public roads and agricultural engineering, as existed in the case cited.

6. The American farmer, whose prosperity and welfare are the aim and purpose of the Department, the Society and the colleges, will gain in many and important though largely indirect ways. He will accept the Department's enhanced valuation of engineering, and give it that increased attention in his own practice which is now the great need and promise of American farming. All along the line, both in and out of official circles, the leadership of the Department will be reflected in more adequate attention to engineered farm production.

7. The outspoken and apparently unanimous belief of agricultural engineers that the proposed change will be of marked benefit to all concerned and the apparent absence of substantial objection thereto, point to the wisdom and expediency of the change, and

WHEREAS this Society is the only organization representing agricultural engineers personally and professionally, and embraces in its membership nearly all of the agricultural engineers of the land-grant colleges and experiment station staffs, agricultural engineers of the U. S. Department of Agriculture, and agricultural engineers associated with allied industries, therefore be it

RESOLVED that it is the sense of the American Society of Agricultural Engineers that the present Division of Agricultural Engineering of the Bureau of Public Roads should be elevated to the rank of a separate bureau of the U. S. Department of Agriculture, to be known as the "Bureau of Agricultural Engineering," and be it further

RESOLVED that the Society respectfully requests that the Secretary of Agriculture give serious and favorable consideration to the proposed change, with a view to recommending that Congress enact, at the earliest possible date, appropriate legislation to create such a bureau, and appropriate sufficient funds to enable the bureau thus created to prosecute its work in a manner and on a scope that is in keeping with the importance of engineering to American agriculture, and be it further

RESOLVED that a copy of this resolution signed by the President and Secretary of the Society be transmitted to the Honorable, the Secretary of Agriculture, William M. Jardine.

ATTEST:

(Signed) OSCAR W. SJOGREN
President
(Signed) RAYMOND OLNEY
Secretary

February 2, 1927

President Sjogren Honored

DURING the attendance of President O. W. Sjogren of the American Society of Agricultural Engineers as the Society's official representative on American Engineering Council at its annual meeting held in Washington, the Washington members of the Society gave a luncheon at the Cosmos Club in his honor on January 15. Dr. Elwood Mead, U. S. Commissioner of Reclamation and an honorary member of the Society, presided at the luncheon, at which nineteen members of the Society living in Washington and vicinity were present.

Agricultural Engineers Entertain

THE agricultural engineering department of the University of Nebraska entertained the Lions Club of Lincoln at a luncheon on January 13. Among other things in the way of entertainment five prizes were offered, which were given out to the most beautiful Lion, the fiercest Lion, the fattest Lion, the leanest Lion, and the smoothest Lion, as picked out by the secretary of the department. These five prizes consisted of a cleaver, a small hammer, a punch, a rolling pin, and a potato masher, all made in the shops of the agricultural engineering department.

There are four engineers in the Lions Club of Lincoln, and in addition to the foregoing prizes a sixth prize was given to one of the engineers, in the form of a year's subscription to AGRICULTURAL ENGINEERING, which went to Herman Jobst, this particular "Lion" not being classified.

Those A.S.A.E. members who attended the banquet during the 1924 annual meeting of the Society at Lincoln have a vivid memory of what royal entertainers the agricultural engineers at the University of Nebraska proved themselves to be on that occasion.

Publications of the National Academy of Sciences

THE National Academy of Sciences, Washington, D. C., has recently issued a 200-page book, entitled "Publications of the National Academy of Sciences of the United States of America (1915-1926" which is Volume 13, No. 152 (January,

1927) of the proceedings of the Academy. The contents are divided into three parts: Part I consists of an index to the first ten volumes of the proceedings of the Academy from 1915 to 1924 and includes a list of the volumes published, and an author and subject index. Part II consists of a list of other publications of the Academy from 1863 to 1926, including memoirs of the National Academy of Sciences, biographical memoirs, reports of committees, annuals, and annual reports. Part III is a list of publications of the National Research Council from 1916 to 1925 including bulletin series, reprint and circular series, and general council publications. The price of this book is $1.50.

Paine Returns to College Work

FRANK D. PAINE, who, for the past year, has been on leave of absence from Iowa State College, acting as assistant director of the National Committee on the Relation of Electricity to Agriculture, has resumed his position as professor in charge of the electrical engineering department of that institution and electrical engineer for the Iowa Engineering Experiment Station. Supervision of the Iowa project on rural electrification will become one of the principal duties of Mr. Paine. Further development of the Iowa work, including extensive analysis of farm processes and the possible adaptation of electricity to these processes, and a program of extension and education will form the major parts of the program. During his connection with the C.R.E.A., Prof. Paine worked out and put into effect an organized plan of cooperation between the manufacturers of electrical equipment and farm machinery and the twenty-one state projects on rural electrification. As a result of this work some two hundred manufacturers have been giving valuable assistance to these projects by loaning equipment for use in experimental work.

Minnesota Well Drillers Meet

AN INTERESTING and instructive program has been planned for the 1927 convention of the Minnesota Well Drillers Association to be held at University Farm, St. Paul, Minnesota, February 9, 10 and 11. The presiding officers will be E. A. Stewart, professor of agricultural engineering of the University of Minnesota, Vice-President B. O. Clauson, and President M. J. Spencer.

One of the most beneficial lectures of the series will be that given Wednesday morning by Ira S. Allison, instructor in geology at the University of Minnesota, on "General Geology Outlines with Special Reference to the Water Geology of Northwestern Minnesota." Wednesday afternoon Mr. Allison will talk on "Simple Tests for Minerals and Rocks", C. E. Dalrymple of the Travelers Insurance Company will speak on "Workman's Compensation Insurance", and an address on steel by T. P. Hughes, instructor in forge work at the University, will be followed by a symposium led by Mr. Hughes.

The Thursday morning session will be given over to the subject "Finishing, Packing and Developing Sand Wells". The various phases of this work will be explained by M. J. Spencer, Keith M. Brown and Peter Cairncross. In the afternoon B. E. Dickey will lecture on "Some Simple and Inexpensive Compressor Units for Use in Ordinary Farm Wells". The relative subject "Developing Wells with Compressed Air", will be treated by Reynold Espe and Fred Ohland, followed by a general symposium. At six in the evening the annual banquet will be held.

Pumping and water supply installations will be the subject of the Friday morning session, A. R. Klopfleisch and E. A. Stewart lecturing. "Problems of an Auger Man", led by F. H. Klemenhagen, and a business meeting will compose the closing afternoon session.

A Correction

IN THE "Agricultural Engineering Digest" section of the January issue of AGRICULTURAL ENGINEERING, on page 18, under the heading "Compressive and Transferred Strength of Hollow Tile Walls," the walls under test were built approximately the size of ordinary panels 16 feet long by 9 feet high instead of 6 feet long as noted.

First Soil Science Congress

THE first congress of the International Association of Soil Science, which will bring together for the first time in this country those interested in problems of soil classification, soil analysis, fertilization and treatment, and relation of soil to plant growth, will convene in Washington, D. C., on June 13, 1927. The organization of the congress includes international commissions on soil physics; chemistry; bacteriology; fertility; nomenclature classification, and topography; and the application of soil science to land cultivation. Each of these commissions is arranging a program of from five to eight sessions and additional sessions will be provided for the congress as a whole and for numerous joint meetings. The congress will be followed by a field trip to various important soil belts in the country, as well as numerous agricultural industries, experiment stations, and other points of interest.

Personals of A.S.A.E. Members

R. U. Blasingame, professor of agricultural engineering at Pennsylvania State College, addressed the meeting of the American Association for the Advancement of Science, (Section O, "Agriculture"), held at Philadelphia, Pennsylvania, December 30, on the subject "Possibilities of Increasing the Production Per Worker in Agriculture."

J. P. Fairbank, extension specialist in agricultural engineering, University of California, announces a new member of the agricultural engineering profession in the person of a young son. (Congratulations!—Editor.)

L. J. Fletcher, formerly associate professor of agricultural engineering, University of California, and C. D. Kinsman, formerly agricultural engineer, division of agricultural engineering, U. S. Department of Agriculture, are joint authors of Bulletin 415, entitled "The Tractor on California Farms," recently issued by the University of California. Copies of the bulletin may be secured by writing the California Agricultural Experiment Station, Berkeley, California.

A. R. Greig, professor of agricultural engineering, University of Saskatchewan, who is a member of the Research Council of Canada, attended a meeting of the council held in Ottawa January 14.

J. Dewey Long, junior agricultural engineer, California Agricultural Experiment Station, is conducting an investigation in the Imperial Valley and Lower California on the causes of failure of adobe and other structures which occurred in Mexicali and Calexico in the earthquake on New Year's Eve.

Stanley F. Morse, consulting agricultural engineer, sailed for South America, January 15, to investigate soil and sugar cane production problems in British Guiana for an English sugar company. He will also visit the Imperial College of Tropical Agriculture in Trinidad.

H. E. Murdock is on a year's leave as head of the department of agricultural engineering, University of Montana. The first semester he spent at the University of California studying economic problems in irrigation and drainage. The remainder of the year will be spent in study and travel in California and Arizona.

E. A. Stewart, professor of agricultural engineering, University of Minnesota, addressed the eighth annual meeting of the Minnesota Farm Bureau Federation on January 19, on the subject "Electricity as an Aid to Agriculture." He will preside at one of the sessions of the convention of the Minnesota Well Drillers Association to be held at University Farm, February 9, 10, and 11, and will also address the convention at another session on the subject, "Pumping and Water Supply Installations for Farms and Other Small Users."

Clara Woolworth, director women's division educational department, J. B. Colt Company, is author of a bulletin recently issued by that company, entitled "The Story of Light," which is an interesting story of the development of artificial lighting with particular reference to carbide gas lighting.